Research: Clean Air

Program Area: Research: Clean Air
Goal: Clean Air and Global Climate Change
Objective(s): Radiation; Enhance Science and Research

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	*$90,271.0*	*$81,917.0*	*$85,322.0*	*$3,405.0*
Total Budget Authority / Obligations	$90,271.0	$81,917.0	$85,322.0	$3,405.0
Total Workyears	261.1	269.5	265.6	-3.9

Program Project Description:

EPA's Clean Air research program provides the scientific foundation for the Agency's actions to protect the air Americans breathe and supports the Administrator's priority for improving air quality. The program provides the underlying research to support the Agency's implementation of the Clean Air Act (CAA), which mandates promulgation and enforcement of the National Ambient Air Quality Standards (NAAQS)[1] as well as the evaluation of risks associated with Hazardous Air Pollutants (HAPs).[2] The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering.

In FY 2008, the program began to move beyond its primary focus on particulate matter (PM)[3] and integrate research activities around a multi-pollutant approach to address ozone and other criteria pollutants as well as HAPs. This reorganization was guided by recommendations from the National Academy of Sciences and the Board of Scientific Counselors (BOSC)—a Federal advisory committee composed of independent expert scientists and engineers—as well as the emerging research needs of EPA's Air and Radiation program. In moving toward the multi-pollutant theme, the program will increasingly focus on how to address specific source sectors contributing to air pollution, a holistic approach that will result in more effective and efficient air quality management strategies. The program currently is guided by a series of NAS reports[4] and a multi-year plan[5] that outlines research needs and plans to meet those needs, and establishes milestones for evaluating the program's progress. Climate and air quality interactions are playing an increasing role in ambient air health assessments, heightening the importance of addressing the possible effect of climate change on air pollution profiles. To meet this challenge, the

1 The NAAQS set limits for criteria pollutants regulating levels of tropospheric ozone, particulate matter, carbon monoxide, sulfur dioxide, nitrogen oxides, and lead. For more information, see http://www.epa.gov/air/criteria.html.

2 For more information, see http://www.epa.gov/ttn/atw/188polls.html

3 For more information, see http://www.epa.gov/airscience/.

4 2004 reports is: NRC, *Research Priorities for Airborne Particulate Matter: IV. Continuing Research Progress*. Washington, DC: http://books.nap.edu/catalog/10957.html and *Air Quality Management in the United States*, http://www.nap.edu/catalog.php?record_id=10728 National Academies Press (2004).

5 For more information, see http://www.epa.gov/ord/npd/pdfs/Air-MYP-narrative-final.pdf

program is working closely with the Global Change research program to develop a framework for research that will be useful to stakeholders charged with public and environmental health.

The scientific findings from EPA's air research inform the development of Integrated Science Assessments, which are periodic reports that synthesize the science relevant to setting the NAAQS. These assessments are prepared by the Human Health Risk Assessment program and used by EPA's Air and Radiation program to develop and propose revisions to the NAAQS. The program also provides the science necessary to support EPA Regional Offices and state regulatory agencies in identifying and designing effective strategies to meet the NAAQS. The research program is integrated with complementary research on the impacts of climate change and mercury conducted under the Research: Global Change and Research: Human Health and Ecosystems programs respectively. While mercury-focused research is being phased out of the Human Health and Ecosystems program, some research performed as part of the multi-pollutant effort under the Clean Air program, in which mercury is one facet of research, will be continued.

A subcommittee of EPA's BOSC conducted an evaluation of the Clean Air research program in June 2009 and noted in their final report that "the quality of the scientific research being conducted is unquestionably outstanding, [and that the Clean Air program] has made substantial progress in answering key science questions and in providing useful input to air quality planning at national, regional, state, and local levels." The BOSC also found that the science was highly informative to the science community itself, and that it has contributed to the advancement of the respective science fields.[6]

FY 2011 Activities and Performance Plan:

In FY 2011, EPA's Clean Air research program will continue to study Americans' exposure to air pollution, and the links between sources of pollution and health outcomes.[7] The program will develop computer models of emissions and the atmosphere, which are used to forecast air quality at local and national scales; predict public exposure to air pollutants; and assist states in developing and validating plans to meet the requirements of the Clean Air Act. The program also will study atmospheric chemistry, such as emission mixtures and the formation of secondary pollutants through in-atmosphere reactions. In addition, the program will develop ambient air sampling techniques; and conduct research to correlate ambient measurements of emissions with both their sources and with levels of human exposure.

EPA will continue its research to understand air pollution near roads, attempting to link roadway emissions with health outcomes.[8] EPA has selected Near-Roadway as a model of how EPA can best approach source-based studies to draw direct relationships between the source and atmospheric concentrations of pollution and how these ambient levels relate to exposure and ultimately health outcomes. EPA is conducting studies in Las Vegas and Detroit, in collaboration with the Federal Highway Administration, to measure and characterize emissions near roads and to understand potential exposures associated with vehicle and roadway "emissions." In FY 2011 EPA will report on studies conducted in Las Vegas to characterize near roadway emissions. EPA

6 The final report is available at: http://www.epa.gov/osp/bosc/pdf/air0910rpt.pdf

7 For more information, see http://www.epa.gov/nerl/goals/air/.

8 For more information, see http://www.epa.gov/nerl/goals/air/linkages.html.

will develop exposure models for individual and multiple pollutants and will use the models to develop risk estimates of health effects. Research also will evaluate the effect of barriers (e.g., structural walls and vegetative barriers) on near-road pollution. Research addressing other sectors (e.g., pulp and paper, petroleum refineries, cement kilns), will similarly employ a holistic and integrated approach.

FY 2011 funding will continue support for research to inform Agency, state and Tribal air quality managers about the sources of air pollution and methods for managing emissions.[9] The program will investigate and apply advanced methods to measure the quantity and chemical composition of airborne toxics and particulate matter emissions from man-made and natural sources. These data support development of improved emission inventories which provide essential data for trend analysis; regional, and local scale air quality modeling; regulatory strategies and impact assessments; and human exposure modeling.[10] These methods also support source apportionment, which traces pollutants measured in ambient air to specific sources based on the unique chemical or structural markers in the pollutants. In addition, the program will generate emission samples from various sources for use in exposure and toxicology studies to understand how health effects vary by source, and develop and evaluate the cost and performance of technologies capable of reducing emissions.

The FY 2011 budget request includes additional research funding to support a next generation monitoring network for ambient air pollutants, including both the NAAQS and HAPs, and will help implement EPA's future air quality policies. Specifically, the research will help replace monitoring methods that are decades old with new instrumentation, especially continuous monitors. Funds will support research to provide field validation of available, untested and undeployed methods, refinement of outdated techniques and methods, and to innovate new technologies.

EPA will continue to develop advanced air quality models, such as the Community Multi-scale Air Quality (CMAQ) model, that simulate transport and fate of pollutants in the atmosphere. These models are used by EPA and National Oceanic and Atmospheric Administration, state and local governments, and the general air pollution research and monitoring community to understand and forecast the location, composition and magnitude of air pollutants, and to develop effective emission control policies and regulations. The research collaboration and coordination supported by the FY 2011 budget request will ensure that the scientific and technical needs of the Air research program continue to be met.

Further, the Agency will continue epidemiological, clinical, and toxicological studies of air pollution's health effects.[11] In FY 2011, a priority area for the program's health effects research will be improving scientific understanding of how particle size and composition from specific sources influences particulate matter–associated health effects. Research will focus on determining how the toxicity of particles differs by particle size and chemical composition; understanding how emissions from different sources affect health; the degree to which genes, lifestyle, age, and diseases like diabetes and asthma affect susceptibility to air pollution; and

9 For more information, see http://www.epa.gov/appcdwww/

10 For more information, see http://www.epa.gov/ttn/chief/eiinformation.html.

11 For more information, see http://www.epa.gov/nheerl/research/cleanair.html.

understanding the mechanisms inside the human body by which air pollution causes harm. EPA also will investigate air pollution's effects on cardiopulmonary, nervous, reproductive, and immune systems and on development during pregnancy and infancy. The program also will conduct epidemiological studies of communities with single emission sources or industrial sectors to improve understanding of how health endpoints are connected to distinct sources of air pollution.

The program makes extensive use of the Science to Achieve Results (STAR) program's competitive, peer-reviewed grants.[12] In FY 2011, to reflect the shift towards a multi-pollutant focus, the program will fund Clean Air Research Centers (previously Particulate Matter [PM] Centers). The Clean Air Centers will address multi-pollutant air problems such as health effects of air pollution mixtures.[13] Current PM Centers, in 2011 and 2012, will publish research results on PM source-health linkages. The program also will continue to fund a ten year research grant (the largest in EPA's history) to the Multi-Ethnic Study of Atherosclerosis (MESA)–Air Pollution Study, investigating the relationship between long term air pollution exposures and the development of cardiovascular disease.[14] STAR also will continue to fund a five year grant to the Health Effects Institute (HEI),[15] a nonprofit research organization cosponsored by EPA and the automotive industry to conduct independent research on the health effects of air pollution from mobile sources. In addition, the program will fund grants to address key gaps in understanding air pollution emissions. These studies will improve knowledge of emissions from on-road and shipping transportation, animal operations and the biological components of particulate matter.

Finally, in collaboration with EPA's Human Health research program and HEI, the Clean Air research program will emphasize development of a framework for assessing the effectiveness of air pollution regulations and control strategies. The framework will be especially important in assessing loss of benefits associated with air quality changes due to changes in climate.

EPA has finalized two long term goals toward which the program commits to work: reducing uncertainty in the science that supports standard-setting and air quality management decisions and assessing the links between sources of air pollution and health outcomes. The program continues working to improve integration of its financial and performance data, developing and finalizing methods for measuring progress toward the program's annual and long term measures, and implementing annual program reviews.

Performance Targets:

The research conducted under this program supports EPA Strategic Objective 1.6. Specifically, the program provides sound science to support EPA's goal of clean air by conducting leading-edge research and developing a better understanding and characterization of human health and environmental outcomes.

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12 For more information, see: http://epa.gov/ncer/science/pm/.

13 For more information, see http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/outlinks.centers/centerGroup/19/

14 For more information, see http://depts.washington.edu/mesaair/.

15 For more information, see http://www.healtheffects.org/.

The program gauges its annual and long term success by assessing its progress toward several key goals. In FY 2011, the program strives to complete 100 percent of its planned actions related to the long term goal of reducing uncertainty in the science that supports standard setting and air quality management decisions. Additionally, the program plans to complete additional work toward a hierarchy of pollutant sources based on the linkages between source emissions and the concentration of pollutants in ambient air, and the risk they pose to human health. Feedback from the ongoing BOSC review is being used to refine this approach.

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percent planned actions accomplished toward the long-term goal of reducing uncertainty in the science that supports standard setting and air quality management decisions. (Research)	100	100	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of Clean Air publications rated as highly cited publications.	33.9	34.1	No Target Established	34.9	Percent

The program's bibliometric measure, which assesses the quality and impact of its scientific publications compared to other publications in the same field, demonstrates that the programs' publications are "highly cited" 3.3 times more than similar publications. In FY 2010, the program aims to further increase its percentage of "highly cited" publications, with a target of 34.9 percent in FY 2011. Achieving these ambitious targets will ensure EPA continues to make significant progress toward providing the research needed to meet its long term clean air goals.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$3,000.0) This reflects an increase to help the Agency develop and maintain a next generation monitoring network for ambient air pollutants, including both the NAAQS and HAPs. In particular, it will provide field validation of available, untested and undeployed monitoring methods, refinement of outdated techniques and methods, and innovative new technologies. This investment in a next generation air monitoring network supports the Agency's priority of improving air quality across the nation by helping replace monitoring methods and monitors.

- (+$1,460.0) This reflects an increase for payroll and cost of living for existing FTE.

- (+$531.0) This represents a restoration of resources transferred in FY 2010 to the Research: Sustainability program to support Small Business Innovation Research (SBIR). For SBIR, EPA is required to set aside 2.5 percent of funding for contracts to small businesses to develop and commercialize new environmental technologies. After the FY 2011 budget is enacted, and the exact amount of the mandated requirement is known, FY 2011 funds will be transferred to the SBIR program.

- (+$34.0 \ +0.1 FTE) This reflects the net result of realignments of FTE and resources such as critical equipment purchases and repairs, travel, contracts, and general expenses to better align with programmatic priorities, including 0.1 FTE with associated payroll of $13.0. Realignments are based on FTE allocations as well as scientific equipment needs.

- (-$137.0) This decrease in travel costs reflects an effort to reduce the Agency's travel footprint by promoting green travel and conferencing.

- (-$687.0 \ -3.0 FTE) This represents realignment to the Global Change program for research on air quality-climate interactions to effectively couple regional air quality and global climate models, including a decrease of 3.0 FTE with decreased associated payroll of $401.0.

- (-$796.0 \ -1.0 FTE) This reduction to the Clean Air research program, including a decrease of 1.0 FTE with decreased associated payroll of $134.0, will reduce lowest priority activities in the acquisition of data and the development and application of models used to understand the relationships between air pollution, ambient concentration and exposures.

Statutory Authority:

CAA; ERDDA.

Research: Drinking Water
Program Area: Research: Clean Water
Goal: Clean and Safe Water
Objective(s): Enhance Science and Research

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	*$43,762.7*	*$49,155.0*	*$52,258.0*	*$3,103.0*
Total Budget Authority / Obligations	$43,762.7	$49,155.0	$52,258.0	$3,103.0
Total Workyears	188.3	190.2	190.8	0.6

Program Project Description:

EPA's Drinking Water Research program (DWRP) conducts comprehensive integrated research in support of EPA's Office of Water and Regional Offices. The program is organized around two long term goals that focus on characterization and management of health risks across the water continuum with an emphasis on sound scientific approaches for ensuring safe and sustainable drinking water.

The program provides methodologies, data, tools, models, and technologies in support of regulatory decisions, health risk assessments and other needs pertaining to the Safe Drinking Water Act's (SDWA) statutory requirements. Research also is targeted at implementation of regulatory decisions, addressing simultaneous compliance issues, promoting the sustainability of water resources, and the reliable delivery of safe drinking water, as well as developing approaches to improve water infrastructure. The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering.

Research in the Drinking Water Research program is coordinated with the Agency's regulatory activities and timelines and is responsive to EPA's Water program and Regional Offices. A major component of the research program is addressing the information gaps associated with chemicals and microorganisms that are on the recently released third Contaminant Candidate List (CCL3) and supporting the unregulated contaminant monitoring rule (UCMR3). Current policy-relevant research topics include the following:

- Research to address revisions to the Total Coliform Rule (R-TCR) and related research on distribution systems;
- Implementation of recent regulatory decisions including the Ground Water Rule, the Stage 2 Disinfection Byproduct Rule (DBP2), and the Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR); and
- Research support for simultaneous compliance challenges, particularly co-compliance with the Lead and Copper Rule (LCR), Microbial and Disinfectant Byproduct (M/DBP) rules, and National Primary Drinking Water Regulations (NPDWR).

Research also is targeted at protecting underground sources of drinking water. A key focus is supporting the Underground Injection Control (UIC) regulations that pertain to geologic sequestration of carbon. In addition, research is being initiated on water resources implications associated with the use of hydraulic fracturing for gas extraction. Several peer-reviewed research strategies[20,21] and guidance from external experts[22,23,24,25] have provided input and guidance for charting the research directions within the DWRP. The Agency's Research and Development program uses Multi-Year Plans[26] (MYPs) to outline how each program will develop and implement research while meeting Annual Performance Goals (APGs) and Annual Performance Measures (APMs) for evaluating progress. National Programs and associated MYPs are subjected to rigorous, external peer review[27]. The Drinking Water MYP was revised, in partnership with the Water program and with input from the Regional Offices, to reflect the new structure of the program and to plan and communicate ongoing and anticipated science activities and regulatory needs for FYs 2009 through 2014.

EPA and its external reviewers, including the EPA Science Advisory Board and the Board of Scientific Counselors, have recognized that a statute-specific research approach is limited in its potential for solving modern environmental problems. While the Drinking Water and Water Quality research program have both made many important contributions to EPA decision making and have worked to integrate various disciplines throughout the programs, they could benefit by building upon important synergies and emerging tools to address these evolving environmental problems. Moving in that direction, portions of the Drinking Water program are being aligned with related aspects of the Water Quality research program. The result will be a more holistic research program that maximizes responsiveness to the rapidly changing needs of EPA's Office of Water and other critical partners, while simultaneously addressing the Administrator's priorities for protecting America's waters.

Efforts will include increased integration of water efficiency concepts and energy-water interdependencies across the program from source water protection to treatment and distribution systems. In addition, more explicit efforts are being made to identify opportunities to improve water supplies in urban communities and small systems in collaboration with the Agency's efforts on Environmental Justice and community-based programs. Potential examples include working with the Office of Water to identify sites for field-based research including monitoring studies, infrastructure evaluation, and epidemiology projects. In addition, the program is continuing its emphasis on developing cost-effective systems that are appropriate for small communities.

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[20] U.S. EPA, Office of Research and Development. *Research Plan for Microbial Pathogens and Disinfection By-Products in Drinking Water.* EPA 600-R-97-122, Washington, D.C.: U.S. Government Printing Office (1997).
[21] U.S. EPA, Office of Research and Development. *Research Plan for Arsenic in Drinking Water.* EPA 600-R-98-042, Washington, D.C.: U.S. Government Printing Office (1998).
[22] National Research Council. *Classifying Drinking Water Contaminants for Regulatory Consideration.* Washington, D.C.: The National Academies Press (2001).
[23] National Academies of Science. *From Source Water to Drinking Water: Workshop Summary.* Washington, D.C.: The National Academies Press (2004).
[24] National Research Council. *Indicators for Waterborne Pathogens.* Washington, D.C.: The National Academies Press (2004).
[25] National Research Council. *Public Water Supply Distribution Systems: Assessing and Reducing Risks--First Report.* Washington, D.C.: The National Academies Press (2005).
[26] U.S. EPA, Office of Research and Development, Drinking Water Research Program Multi-Year Plan. Washington, D.C. Available at: http://www.epa.gov/osp/myp.htm.
[27] Science Advisory Board. *Review of EPA's 2003 Draft Drinking Water Research Program Multi-Year Plan* (2005). Available at: http://www.epa.gov/sab/pdf/sab-05-008.pdf.

FY 2011 Activities and Performance Plan:

In FY 2011, the Drinking Water Research program will continue its evolution towards conducting more integrated multidisciplinary research focused on characterizing and managing health risks associated with surface and underground sources of drinking water, treatment strategies, and distribution/storage systems and water infrastructure. The program has made a progressive shift from addressing individual contaminants on a case-by-case basis toward developing approaches for screening, prioritizing and evaluating health risks associated with exposure to environmentally relevant chemical and microbiological contaminants and mixtures. A key emphasis will be on conducting integrated research that links water availability and quality issues with regulatory drivers including the role of water reuse, green infrastructure, alternative design approaches, and the impact of centralized/decentralized treatment and distribution on drinking water quality.

The program is organized around five theme areas: exposure/health effects, assessment tools, source water/water resources, treatment strategies, and distribution/storage/infrastructure. This structure provides opportunities for integrating health risk research with questions relevant to water availability, water efficiency and energy considerations, and expanding the risk characterization-risk management paradigm. Anticipated products for FY 2011 are listed below by thematic area.

Exposure/Health Effects: A major research focus is clarifying potential health effects of CCL contaminants. New efforts are being initiated to characterize potential exposure and health significance of disinfection byproducts (DBPs) with an emphasis on the use of alternatives to chlorine disinfection. Epidemiological studies of drinking water contaminant risks also are being initiated. Work in FY 2011 will focus on:

- Developing and applying new research tools to characterize, screen, and prioritize potential health effects of chemical contaminants and contaminant mixtures (including emerging contaminants), and provide support in assessing those effects; and
- Developing approaches to evaluate the relative potency and toxicity of water disinfected by different processes (with a focus on alternative treatments, such as chloramination and ozonation), and characterize the health effects impact of treatment interactions with varied source water characteristics.

Assessment Tools: Research is focused on developing reliable characterization tools to enable screening, sample analysis, and modeling of waterborne chemicals, indicators and pathogens. Research products in this area will enable quantification of CCL chemicals and pathogens in support of the Unregulated Contaminant Monitoring Rule and other water monitoring applications. Biomarkers of exposure and measurement methods (recovery, viability, speciation) will be further developed. FY 2011 efforts will support the following:

- Demonstrate applications of proteomics for characterizing waterborne pathogens.
- Develop new and/or improved analytical method(s) to measure emerging and/or CCL related chemicals to collect occurrence data under the UCMR.

- Produce analytical techniques to quantify toxic arsenicals in cells and tissue samples to support mode of action research.
- Produce innovative methods for the concentration, recovery, and assessment of protozoa, viruses, and bacteria from large volumes of water.
- Characterize naturally-occurring amoeba-resistant bacteria from water samples.

Source Water/Water Resources: A special emphasis for FY 2011 is to address high priority research questions related to the safety of drinking water and the safety, reliability, and sustainability of drinking water infrastructure. In addition, the program will expand its work on underground sources of drinking water to incorporate research on potential water supply consequences (quality and availability) associated with hydraulic fracturing activities and the effectiveness of existing and alternative mitigation strategies.

Research in this area will characterize health risks associated with drinking water sources, develop tools that allow for identification of impacted and susceptible water sources, and establish links between water availability and changes in water quality. Protection of surface water and ground water sources of drinking water requires reliable monitoring methods coupled with implementation of best management practices (BMPs). There will be a shift in FY 2011 towards an increased emphasis on protecting ground water sources with a focus on underground injection control (UIC), aquifer storage and recovery (ASR), and ground water recharge. Research will continue toward answering key questions associated with minimizing risks of geologic sequestration of carbon on underground sources of drinking water (USDW). For FY 2011, efforts will focus on the following:

- Developing models to assess risk associated with underground injection of carbon dioxide, field monitoring techniques to assess leakage of injected carbon dioxide into sources of drinking water, and tools to support implementation aspects of the proposed UIC rule on geological sequestration; and
- Assessing the ability of various drinking water treatment technologies to remove selected potential endocrine disrupting chemicals that may be in source water.

In FY 2011, research on underground sources or drinking water will be expanded to address potential water supply consequences associated with hydraulic fracturing, a potentially important aspect of energy resource exploration and management. Congress has urged EPA to conduct this research, which supports the Agency's priority to restore and protect the quality of the nation's waters by ensuring the protection of our aquifers. Research will focus on developing a systems approach for assessing direct and indirect consequences of hydraulic fracturing activities on sources of drinking water, with an emphasis on modeling, monitoring, and mitigation strategies. The research program will include funding for STAR grants to leverage the expertise of top scientists in academia. In addition, it will integrate regionally based field activities to provide a national perspective on potential opportunities for improved safeguards. The program also will study options to optimize water and energy efficiency throughout the lifecycle of hydraulic fracturing activities.

Treatment Strategies: The emphasis of the research will be on evaluating existing treatment strategies for control of CCL and other emerging contaminants, development of point-of-

use/point-of-entry systems for small systems, implementation issues for regulated contaminants, and preventing simultaneous compliance issues. Major focus areas include disinfection efficacy, control of emerging contaminants, corrosion control, and optimizing energy and water efficiency in producing and delivering potable water.

Distribution/Storage/Infrastructure: Integrated research efforts will be directed at water supply distribution systems and infrastructure. The Drinking Water Research program will support the Agency's involvement in the "Distribution System Research and Information Collection Partnership" with a focus on infrastructure, biofilms, nitrification, and contaminant accumulation. This work is in support of the revisions to the Total Coliform Rule (TCR) and the next round of six year review. Research will continue in support of the Lead and Copper Rule (LCR):

- Studies will be conducted to better understand the growth and colonization of viral, bacterial and protozoan pathogen in distribution systems; the role of free-living amoebae in fate, transport and infectivity; and nitrification reactions that occur in distribution systems, accumulation, mobilization and disinfection of contaminants from distribution systems including lead, arsenic, and vanadium.
- Research started in FY 2007 under the "Water Infrastructure for the 21st Century" Initiative, will continue in FY 2011 and will include focusing on field investigations and modeling of how distribution system characteristics (age, materials, capacity) and management/operation practices (flushing, pressure, hydrodynamics, storage, mixing of water sources, corrosion control) impact system integrity and performance including biofilms, water chemistry, corrosion, and drinking water quality.
- The Agency will explore integrated approaches for managing and assessing risks in the distribution system and the development of innovative, real-time condition assessment, technology, and repair or rehabilitation techniques through increased use of full-scale demonstrations.
- Research will continue on the effects of corrosion and accumulation of contaminants in the distribution system.

The program also will continue research in support of the Ground Water Rule and the Enhanced Surface Water Treatment Rule. Modeling and field studies will continue to address UIC research needs associated with geologic sequestration of carbon.

By conducting research in support of SDWA, this research program will assist the Agency in pursuing its strategic objective of providing, by 2011, drinking water that meets all applicable health-based drinking water standards to 91 percent of the population served by community water systems.

Additionally, in FY 2011 portions of the Drinking Water research program will be aligned with portions of the Water Quality research program to focus on high priority problems affecting water quality and availability. This base shift will improve understanding of critical water resource questions with cross-cutting implications for drinking water and water quality.

Performance Targets:

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned risk management research products delivered to support EPA's Office of Water, Regions, water utilities, and other key stakeholders to manage public health risk.	100	93	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned methodologies, data, and tools delivered in support of EPA's Office of Water and other key stakeholders needs for developing health risk assessments under the SDWA.	100	100	100	100	Percent

The research conducted under this program supports EPA Strategic Objective 2.3 – Enhance Science and Research. Specifically, the program conducts leading-edge, sound scientific research to support the protection of human health through the reduction of human exposure to contaminants in drinking water.

The program gauges its annual and long term success by assessing its progress on several key measures. In 2011, the program will strive to complete 100 percent of its planned outputs in support of long term goals. In achieving these targets, the program will contribute to EPA's goal of protecting human health through the reduction of human exposure to contaminants in drinking water.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$2,471.0 \ +3.0 FTE) This reflects an increase for research on hydraulic fracturing and its impact on drinking water and includes an FTE increase of 3.0 with associated payroll of $381.0. Research will provide policy relevant methods, models, monitoring tools, and data on potential risks to water resources associated with extracting gas from subsurface formations using vertical and horizontal fracturing technologies. The research program includes funding for STAR grants to leverage the expertise of top scientists in academia. Congress has urged EPA to conduct this research, which supports the Agency's priority to restore and protect the quality of the nation's waters by ensuring the protection of our aquifers. The request brings the research on hydraulic fracturing program total to $4.4 million and 6.0 FTE.

- (+$1,158.0) This reflects an increase for payroll and cost of living for existing FTE.

- (+$216.0) This represents a restoration of resources transferred in FY 2010 to the Research: Sustainability program to support Small Business Innovation Research (SBIR). For SBIR, EPA is required to set aside 2.5 percent of funding for contracts to small businesses to develop and commercialize new environmental technologies. After the FY 2011 budget is enacted, when the exact amount of the mandated requirement is known, FY 2011 funds will be transferred to the SBIR program.

- (+$65.0K) This realignment of resources from the Land Protection and Remediation program reflects the natural evolution in research direction from groundwater remediation issues to groundwater protection issues related to carbon sequestration.

- (-$98.0) This decrease in travel costs reflects an effort to reduce the Agency's travel footprint by promoting green travel and conferencing.

- (-$709.0 \ -2.4 FTE) This reflects the net result of realignments of FTE and resources such as critical equipment purchases and repairs, travel, contracts, and general expenses to better align with programmatic priorities, and includes a 2.4 FTE reduction with decreased associated payroll of $304.0. Realignments are based on FTE allocations as well as scientific equipment needs.

Statutory Authority:

SDWA; CWA; ERDDA; MPRSA.

Research: Water Quality
Program Area: Research: Clean Water
Goal: Clean and Safe Water
Objective(s): Enhance Science and Research

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	*$64,926.0*	*$61,918.0*	*$68,858.0*	*$6,940.0*
Total Budget Authority / Obligations	$64,926.0	$61,918.0	$68,858.0	$6,940.0
Total Workyears	235.5	236.8	244.9	8.1

Program Project Description:

The Water Quality research program is designed to support the Clean Water Act (CWA), providing scientific information and tools to the Agency and others to help protect and restore the designated uses of water bodies that sustain human health and aquatic life. The program conducts research on the development and application of water quality criteria; the implementation of effective watershed management approaches; and the application of technological options to restore and protect water bodies using information on effective treatment and management alternatives.

The Water Quality research program is responsive to the needs of EPA's Water program and Regional Offices, which are the program's primary clients in developing research priorities, and also supports the Administrator's priority of protecting America's waters. The Agency maintains a Water Quality research program Multi-Year Plan[28] (MYP) that outlines steps and provides a timeline for meeting these needs along with related annual performance goals and measures for evaluating progress. The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering.

EPA and its external reviewers, including the EPA Science Advisory Board and National Science Foundation, have recognized that a statute-specific research approach is limited in its potential for solving modern environmental problems. While the Water Quality research program and Drinking Water research program have both made many important contributions to EPA decision making and have worked to integrate various disciplines throughout the programs, they could benefit by building upon important synergies and emerging tools to address these evolving environmental problems. Moving in that direction, portions of the Water Quality research program are being aligned with related aspects of the Drinking Water research program. The result will be a more holistic research program that maximizes responsiveness to the rapidly changing needs of EPA's Water program and other critical partners.

28 U.S. EPA, Office of Research and Development, *Water Quality Research Program Multi-Year Plan.* Washington, D.C.: EPA. Available at: http://www.epa.gov/osp/myp.htm.

EPA's Board of Scientific Counselors (BOSC)—a Federal advisory committee composed of independent expert scientists and engineers—conducted a review in June 2009 of WQRP and determined that it is serving its clients well in conducting critical research to meet the regulatory mandates of the Clean Water Act. BOSC noted that the WQRP is making an exceptional effort to obtain client input, but more effort is needed to establish a mechanism for quantifying long term outcomes of the program. The progress made by the WQRP in response to the previous BOSC review was assigned an overall rating of "Meets Expectations" but the BOSC found that the program was exceeding expectations in several areas with respect to quality of research.

FY 2011 Activities and Performance Plan:

Research efforts within the Water Quality research program are aligned with the Agency's strategic objectives[29] under the CWA to promulgate protective standards, identify contaminant contributions to impaired waters, use tools to restore and protect the nation's waters with due consideration to minimizing impacts from point and non-point sources of contamination, and maintain and improve the nation's aging infrastructure.

Water quality research, addressing key uncertainties, is critical to the Agency's efforts to protect America's water. Although the quality of the nation's waters has shown improvement, threats to water quality remain, and new threats continue to be identified. In FY 2011 the Water Quality research program will support priorities set in consultation with EPA's Water program and Regional Offices, taking into account such factors as pollutant/stressor type, water body types, and source of pollutants (e.g. agricultural versus urban). In particular, urban watershed management is a top Agency priority. Therefore, the budget request includes a substantial increase for green infrastructure research to facilitate the nation's transition to more sustainable water infrastructure systems and watershed management practices. This and other Water Quality research is categorized within three broad areas: Water Quality Integrity Research; Watershed Management Research; and Source Control and Management Research.

Water Quality Integrity research priorities support regulatory-driven needs related to revising aquatic life guidelines for toxics and emerging contaminants, for example, pharmaceuticals and personal care products (PPCPs), recreational water criteria (beaches research), nitrogen and phosphorus criteria, and sediments. Research also will continue on developing approaches for addressing multiple stressor effects on stream biota and on invasive species. In FY 2011, research will continue to help provide the data and analysis to support revisions to recreational water criteria as well as support implementation of revised criteria. EPA's water program is the major client for research products under this program and will use them in the development and application of water quality criteria. Projects to support criteria development will be completed by December 2010, and consequently some beaches research resources will be redirected to support hydraulic fracturing research within the Drinking Water research program.

Research on diagnostic methods to identify contaminant contributions to impaired waters will enable EPA to continue its focus on the causes and sources of aquatic system impairment. Specifically, this research will provide the scientific foundation and information management

[29] U.S. EPA, Office of the Chief Financial Officer, 2006-2011 EPA Strategic Plan, Washington, D.C. EPA. Available at http://www.epa.gov/ocfo/

scheme for an integrated process for assessing, listing, and reporting water quality conditions that meet or fail to meet statutory requirements, including a classification framework for surface waters, watersheds, and regions. As EPA directs and informs the efforts of the states to adopt nutrient criteria for individual water bodies, research is required to identify nutrient responses based on geographic region, water body type, and designated use. Research will continue toward linking stressor-response relationships to a biological condition gradient and the Tiered Aquatic Life Uses (TALU) framework, while providing information on technical guidance for the development of nutrient water quality criteria for coastal wetlands and estuaries and the Great Lakes.

The Water Quality program supports the adoption and implementation of watershed management approaches by states and tribes as they require strong standards, monitoring, Total Maximum Daily Load (TMDL) determinations, and implementation programs, including best-management practices, restoration, and TMDL watershed plans. Research in this area will develop tools and processes to identify or measure the following:

- Impaired or vulnerable resources,
- Threats and causes of impairment for effective decision making,
- Ways to reduce impairment and vulnerability, and
- The effectiveness of implemented management measures.

In FY 2011, this research will help the Agency address the quality of our neglected urban rivers. Many municipalities are faced with multi-million dollar costs associated with controlling wet weather flow and particularly combined sewer overflows (CSOs). Green infrastructure options have the potential to reduce costs of control compared to traditional "grey" (concrete and steel) infrastructure, but are less proven. Therefore, research will be conducted on wet weather flow problems in urban areas and innovation in green infrastructure, identifying ways to improve efficiency as well as evaluate and measure effectiveness. A significant portion of funds will support Science to Achieve Results (STAR) grants to leverage the most innovative thinking by academia's top scientists. In addition to evaluating the comparison of green and "grey" infrastructure, research will focus on the combination of the green with the "grey" infrastructure to achieve control of wet weather flow. Additional research will document and critically review green urban watershed management case studies, incorporating green infrastructure in a manner that will be widely useful to urban planners and water resource managers.

Watershed management research also will continue to support the TMDL allocation processes with the development of information and integrated water quality and quantity modeling and monitoring tools, including tools for targeting and prioritizing, monitoring, and restoration of watersheds and their subsystems. This research supports assessing condition, including providing technical support to the EPA National Aquatic Resources Assessments (NARS) which is critical for determining impaired resources and the condition of the nation's water bodies in a scientifically defensible manner. It includes the development of tools for assessing and diagnosing of impairment, selecting mitigation options, and measuring and determining success. It also includes support for CWA Section 305(b) reporting, use attainability analyses identifying designated uses, and TMDL adaptive management. Research activities in this area also include Gulf of Mexico Hypoxia research which supports EPA's efforts on the Mississippi River Basin

Watershed Nutrient Task Force to address goals of developing a risk-based forecasting capability to aid water resource managers in making scientifically defensible nutrient management decisions to reduce the hypoxia problem, restore the natural habitats, and restore food web assemblages along the Gulf Coast.

Other research addresses identifying the locations and connectivity of headwater streams and wetlands (complementary research on how and what role headwater streams and isolated wetlands play in reducing pollutant loads, and their effect on downstream quality is being conducted under the Agency's Ecological research program to enhance our understanding of the benefits and value of ecological services). In addition, the program will continue to invest in technical assistance for watershed modeling, decision support tools, and monitoring the biological condition of the nation's aquatic resources. Key users of these products will be at the regional, state, and local level.

Research will continue on the development of microbial source tracking (MST) indicators that can be used to distinguish human from non-human pathogens as well as different sources of non-human pathogens (e.g., cows versus geese). Research will be conducted to improve water quality modeling to better predict pathogen and fecal indicator loadings, concentrations, and associated health risks. The results of this research support the development and implementation of revisions to the ambient water criteria for recreational settings. In particular, such work supports improved TMDLs that will more accurately identify and allocate loadings from the sources of pathogens that must be managed to meet water quality standards.

In addition, existing models of pollutant transport and fate will be expanded to allow the evaluation of alternative strategies for restoring and protecting local and state watersheds. Particular emphasis will be placed on strategies for nutrient control in rural/agrarian settings and on strategies for pollutant control in urban settings. Approaches will be studied for effectively monitoring the reduction of pollutants in the water column, and improvements in aquatic ecosystems, and for demonstrating the effectiveness of protecting designated uses from future development or other impacts.

The preservation and restoration of wetlands will be supported with research on how wetland processes assimilate nutrient contaminants. The water quality research that defines wetland performance is fundamental to the implementation of water quality trading programs. It will include a comparison of natural and constructed wetlands to determine how seasonal changes in hydrologic regime, stressor load, and upland land use affect the functioning of these systems and will inform the protection and restoration of wetlands. Economic assessments of the use of wetlands in water quality trading also will be conducted.

Research on the release of pathogens and pathogen indicator organisms from manure-treated farmlands is needed to ensure that environmentally responsible practices are available to the agricultural community. Field studies at concentrated animal feed operations (CAFOs) will determine the magnitude of releases to groundwaters and surface waters and evaluate control options with emphasis on pathogen and nutrient contaminants. This work will support the development of effective TMDLs and National Pollutant Discharge Elimination System (NPDES) permits.

Source Control and Management (SCM) research priorities will develop information and tools to characterize, control, and manage point and non-point sources of water quality impairment. Research addresses aging infrastructure, green infrastructure, wet weather flows and residuals management. Major users of these products will be the Agency, states, regional authorities and municipalities.

Research will continue on the public health and environmental risk posed by microbial releases from publically-owned treatment works (POTWs) during periods of significant wet weather events. During these events wastewater flow may exceed POTW treatment capacity, resulting in diversion of wastewater around secondary treatment units followed by recombination (i.e.,"blending") with flows from the secondary treatment units or discharging it directly into waterways from the treatment plant.

In FY 2011, research will continue on the development of innovative solutions to manage the nation's aging wastewater infrastructure. Research started in FY 2007 under the Water Infrastructure for the 21st Century initiative will continue to develop the science and engineering to improve and evaluate promising innovative technologies and techniques to increase the effectiveness and reduce the cost of operation, maintenance, and replacement of aging and failing wastewater conveyance systems. Research efforts will demonstrate technologies and approaches for new and innovative condition assessment, rehabilitation, and design of wastewater collection systems and comprehensive asset management. This research will support EPA in developing policy and revolving funds allocation decisions to address this multi-billion dollar problem faced by the nation, and will support utilities and other stakeholders involved in meeting community watershed management goals and in the cost-effective assessment, rehabilitation and management of their systems.

Research on the performance of non-point source BMPs will be conducted in order to provide information to watershed managers and others for the more cost-effective reduction of pollutant loading to surface waters. Particular emphasis will be placed on green infrastructure, a component of aging water infrastructure research, (see below) and on the variation of BMP cost and performance with geographical and other major influencing variables. EPA will continue to support the Pathogens Equivalency Committee (PEC) which evaluates innovative approaches to sewage sludge treatment for the purposes of determining whether they meet requirement of Part 503 (biosolids) regulations.

The Water Quality research program has implemented several actions to improve management and performance. Researchers in the Water Quality and Drinking Water research programs are working together on integrated, goal-oriented issues. Efforts are underway to plan and execute work in a more integrated fashion to adapt to and address the future of water resources management. This will help ensure that natural and engineered aquatic systems have the capacity and resiliency to meet current and future water quality needs to support growing societal, industrial, agricultural, and ecological water availability requirements. Additionally, in FY 2011 portions of the Water Quality research program will be aligned with portions of the Drinking Water research program to focus on high priority problems affecting water quality and availability. This base shift will improve understanding of critical water resource questions with cross-cutting implications for water quality and drinking water.

Performance Targets:

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs (in support of WQRP long-term goal #1) delivered	100	100	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs (in support of WQRP long-term goal #2) delivered	100	86	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs (in support of WQRP long-term goal #3) delivered	100	100	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of WQRP publications in high impact journals.	No Target Established	Biennial	15.7	No Target Established	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of WQRP publications rated as highly cited publications.	No Target Established	Biennial	16.7	No Target Established	Percent

The research conducted under this program supports EPA Strategic Objective 2.3—Enhance Science and Research. Specifically, the program conducts leading-edge, sound scientific research to support the protection of human health through the reduction of human exposure to contaminants in fish, shellfish, and recreational waters, as well as to support the protection of aquatic ecosystems. In FY 2011, the program plans to accomplish its goals of completing and delivering 100 percent of its planned outputs. In achieving these targets, the program will contribute to EPA's goal of protecting water quality and human health.

FY 2010 Change from FY 2011 Enacted Budget (Dollars in Thousands):

- (+$5,950.0 \ +7.0 FTE) This reflects a more than doubling of funding for green infrastructure research to improve urban watershed management practices and facilitate the nation's transition to more sustainable water infrastructure systems. The increase also includes 7.0 FTE with associated payroll of $915.0. A significant portion of funds will support STAR grants to leverage the most innovative thinking by academia's top scientists.

- (+$1,036.0) This reflects an increase for payroll and cost of living for existing FTE.

- (+$863.0 \ +1.1 FTE) This reflects the net result of realignments of FTE and resources such as critical equipment purchases and repairs, travel, contracts, and general expenses to better align with programmatic priorities, and includes 1.1 FTE with associated payroll of $143.0. Realignments are based on FTE allocations as well as scientific equipment needs.

- (+$183.0) This represents a restoration of resources transferred in FY 2010 to the Research: Sustainability program to support Small Business Innovation Research (SBIR). For SBIR, EPA is required to set aside 2.5 percent of funding for contracts to small businesses to develop and commercialize new environmental technologies. After the FY 2011 budget is enacted, and the exact amount of the mandated requirement is known, FY 2011 funds will be transferred to the SBIR program.

- (-$92.0) This decrease in travel costs reflects an effort to reduce the Agency's travel footprint by promoting green travel and conferencing.

- (-$1,000.0) This reflects a realignment of resources previously supporting science needs for the five year review and revision process for recreational criteria (Beaches program), to hydraulic fracturing work within the Drinking Water research program. In particular, as the Beaches work nears completion, human health effects work will be discontinued.

Statutory Authority:

CWA; ODBA; SPA; CVA; WRDA; WWWQA; MPPRCA; NISA; CZARA; CWPPRA; ESA; NAWCA; FIFRA; TSCA; ERDDA.

Research: Land Protection and Restoration
Program Area: Research: Land Protection
Goal: Land Preservation and Restoration
Objective(s): Enhance Science and Research

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	*$11,696.8*	*$14,111.0*	*$13,800.0*	*($311.0)*
Leaking Underground Storage Tanks	$424.1	$345.0	$457.0	$112.0
Oil Spill Response	$382.8	$639.0	$689.0	$50.0
Hazardous Substance Superfund	$19,010.1	$21,191.0	$19,069.0	($2,122.0)
Total Budget Authority / Obligations	$31,513.8	$36,286.0	$34,015.0	($2,271.0)
Total Workyears	141.4	154.7	150.7	-4.0

Program Project Description:

Research performed under the Land Research program supports scientifically defensible and consistent decision making for Resource Conservation and Recovery Act (RCRA) material management, corrective action, and emerging materials topics. EPA's Land Research program provides the scientific foundation for the Agency's actions to protect America's land and supports the Administrator's priorities for assuring the safety of chemicals and cleaning up our communities. Research under this program has been evolving from waste treatment to beneficial reuse, avoidance of more toxic materials, and operation of waste management facilities to conserve capacity and produce energy. Research addresses resource conservation and material reuse issues, as well as the application of alternative landfill covers and the benefits of landfill bioreactors. To address emerging material management issues, the program made a strategic shift to focus on nanomaterial fate and transport and associated risk management issues.

Research efforts are guided by the Land Research Program Multi-Year Plan (MYP),[70] developed with input from across the Agency. The MYP outlines steps for meeting the needs of the Research and Development program's clients and stakeholders and for evaluating progress through annual performance goals and measures. Research under this program supports human health risk and exposure assessments and methods, which are conducted under the Human Health Risk Assessment program. The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering.

The Land Protection and Restoration research program has taken a number of steps to improve effectiveness and demonstrate results. To enhance communication with customers, the program has developed a Land Research program Web site[71] that includes a description of the program;

[70] EPA, Office of Research and Development, *Land Research Program MYP.* Washington, D.C.: EPA. For more information, see http://www.epa.gov/ord/htm/multi-yearplans.htm#land.
[71] For more information, see www.epa.gov/landscience.

fact sheets (science issues, research activities, and research impacts); research publications and accomplishments; and links to tools and models. In addition, the program continues to leverage external evaluations by a subcommittee of EPA's Board of Scientific Counselors (BOSC)—a Federal advisory committee composed of independent, expert scientists and engineers. In their most recent report to EPA in FY 2009, building on the full program evaluation in FY 2006, the BOSC found that the Land program has an MYP that articulates research goals for meeting the critical needs of the program. The BOSC also indicated that the Land Research program is responsive to BOSC recommendations and "exceeds expectations" in achieving its program goals.[72]

FY 2011 Activities and Performance Plan:

In FY 2011, resources will continue to support research to address material management, land reuse and revitalization issues, and emerging research topics. Under land reuse, the program works with states to optimize operations and monitor several landfill bioreactors to determine their potential to provide alternative energy in the form of landfill gas while increasing the nation's landfill capacity. These bioreactors will contribute to resource conservation by accelerating waste decomposition not only for preservation of disposal capacity, but more importantly for methane capture and energy recovery. This research directly contributes to Land Restoration long term goals and will aid states and facility owners in pursuing permits for research and development of alternative options for disposal. The Agency works with the Association of State and Tribal Solid Waste Management Officials (ASTSWMO) to assist in the communication of research results on landfill bioreactors to the states. Research will continue on management options for construction and demolition debris including materials such as drywall.

The Land research program also will continue methamphetamine lab clean up studies in response to the Methamphetamine Remediation Research Act,[73] which requires EPA to evaluate clean up techniques and exposure risks. EPA will collaborate on methamphetamine lab clean up studies with the National Institute of Standards and Technology (NIST).

As part of the Land Research program, EPA conducts integrated scientific studies that support site-specific arsenic bioavailability and the development of in-vitro methods and speciation methods. The bioavailability of metals in soils, sediments, and materials for reuse is an important issue in reuse assessments, and research products will provide critical information to support reuse risk assessments. Improving the bioavailability estimate may substantially reduce the cost of soil remediation.

Research directly supporting regulation of coal combustion residues (CCR) management is a high priority in FY 2011. Planned research products will continue to assess CCR leaching potential to support risk assessments. Researchers will also continue to develop a decision support tool for decision makers to evaluate management methods for coal ash for disposal or beneficial reuse.

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[72] BOSC Land Restoration and Preservation Research Mid-Cycle Subcommittee Report. For more information, see http://www.epa.gov/osp/bosc/pdf/landmc0901rpt.pdf.

[73] For more information, see P.L. 110-143 at http://thomas.loc.gov/.

Under EPA's nanomaterial research program, described in more detail in Research: Human Health and Ecosystems, the Land Research program addresses the fate and transport research theme. The FY 2011 nanotechnology budget request is $20 million, including $3.7 million in the Land research program, $13.9 million in the Human Health and Ecosystem research program, $2 million in the Fellowships program, and $0.23 million in both the Air and Sustainability research programs. The program's goal is to lead the Federal government in addressing key science questions on the persistence and movement of nanomaterials in the environment. In FY 2011, the program will:

- Publish research, begun in FY 2007, on the detection and measurement of nanomaterials. This research will support investigation of environmental fate, transport and characterization in the environment.
- Develop predictive tools to characterize nanomaterials in multiple media.
- Produce a report evaluating the properties of nanomaterials that affect fate, transport, reactivity, and bioavailability.
- Publish a report on the state-of-the-science for sampling and measurement of nanomaterials in environmental media.
- Utilize nanoscale materials to effect remediation of contaminants, notably the use of zero-valent iron to degrade organic contaminants. This research is applicable to contaminated sediment and ground water sites but in FY 2011 the program plans to expand to explore other nanomaterials and contaminants in other media, such as air and drinking water.
- Conduct research on greener synthesis of nanomaterials to provide industry with a model for more benign manufacturing.
- Life cycle assessment and supporting research across media will improve our understanding of where nanomaterials enter the environment, how they result in human or ecological exposures, and identify where management techniques could be applied if controls are necessary.

Performance Targets:

Work under this program supports EPA's Objective 3.3: Enhance Science and Research. Specifically, the program provides and applies sound science for protecting and restoring land by conducting leading-edge research, which, through collaboration, leads to preferred environmental outcomes.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$10.0) This represents a restoration of resources transferred in FY 2010 to the Research: Sustainability program to support Small Business Innovation Research (SBIR). For SBIR, EPA is required to set aside 2.5 percent of funding for contracts to small businesses to develop and commercialize new environmental technologies. After the FY 2011 budget is enacted, and the exact amount of the mandated requirement is known, FY 2011 funds will be transferred to the SBIR program.

- (-$31.0) This decrease in travel costs reflects an effort to reduce the Agency's travel footprint by promoting green travel and conferencing.

- (+$27.0 \ +0.5 FTE) This reflects the net result of realignment of FTE and resources such as critical equipment purchases and repairs, travel, contracts, and general expenses to better align with programmatic priorities, including an increase of .5 FTE with associated payroll of $68.0. Realignments of these resources are based on FTE allocations as well as scientific equipment needs.

- (-$335.0 \ -2.0 FTE) This reflects a redirection of resources to Drinking Water research, reflecting the natural evolution in research direction from groundwater remediation issues to groundwater protection issues related to carbon sequestration. This reduction includes 2.0 FTE with decreased associated payroll of $270.0.

- (+$18.0) This reflects an increase for payroll and cost of living for existing FTE.

Statutory Authority:

SWDA; HSWA; ERDDA; SARA; CERCLA; RCRA; OPA; BRERA; MRRA.

Research: Land Protection and Restoration
Program Area: Research: Land Protection
Goal: Land Preservation and Restoration
Objective(s): Enhance Science and Research

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	$11,696.8	$14,111.0	$13,800.0	($311.0)
Leaking Underground Storage Tanks	$424.1	$345.0	$457.0	$112.0
Oil Spill Response	$382.8	$639.0	$689.0	$50.0
Hazardous Substance Superfund	***$19,010.1***	***$21,191.0***	***$19,069.0***	***($2,122.0)***
Total Budget Authority / Obligations	$31,513.8	$36,286.0	$34,015.0	($2,271.0)
Total Workyears	141.4	154.7	150.7	-4.0

Program Project Description:

EPA's Land Research program provides the scientific foundation for the Agency's actions to protect America's land. As such, this program is a vital component of EPA's efforts to reduce and control chemical risks to human health and the environment. The Land Research program provides essential research to EPA's Superfund program and Regional Offices to enable them to accelerate scientifically defensible and cost-effective decisions for cleanup at complex contaminated sites. Research themes include contaminated sediments, groundwater, and site characterization issues. The research program also provides site-specific technical support through EPA labs and centers, as well as liaisons in each Regional Office. The range of research programs and initiatives will both continue to develop a better understanding of the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering.

Research within this program is responsive to the Superfund law requirements under Section 209(a) of Pub. L. 99-499, which call for "...a comprehensive and coordinated Federal program of research, development, demonstration, and training for the purpose of promoting the development of alternative and innovative treatment technologies that can be used in response actions under the CERCLA program." These research efforts are guided by the Land Research program Multi-Year Plan (MYP)[19] which outlines steps for meeting the needs of Agency programs and for evaluating progress through annual performance goals and measures. To enhance communication with customers, EPA has developed a Land Research program Web site.[20] The site includes a description of the program; fact sheets on science issues, research activities, and research impacts; research publications and accomplishments; and links to tools and models.

[19] EPA, Office of Research and Development, *Land Research Program MYP*. Washington, DC : EPA. For more information, see http://www.epa.gov/ord/htm/multi-yearplans.htm#land.
[20] For more information, see http://www.epa.gov/landscience.

The Land Protection and Restoration research program underwent an external evaluation by a subcommittee of EPA's Board of Scientific Counselors (BOSC)—a Federal advisory committee composed of independent, expert scientists and engineers. The 2009 BOSC report noted that the program has appropriate research goals and has been responsive to prior recommendations for strengthening the program. The program received a rating of "exceeds expectations."[21]

FY 2011 Activities and Performance Plan:

In FY 2011, research will continue to advance EPA's ability to accurately characterize the transport and uptake of chemicals from contaminated sediments and determine the range of and scientific foundation for remedies. Research will focus on improving site characterization and monitoring the effectiveness of remediation and evaluation of novel remedial options. This work directly supports the program's long term goal for the mitigation, management and long term stewardship of contaminated sites. Recent accomplishments include a study on the Ashtabula River in Ohio, which answered science questions on sediment resuspension during dredging remediation, as well as release and transport of contaminants from dredging sites. Similar work on evaluating the Ottawa River dredging project in Ohio is scheduled to continue in FY 2011. The application of Biota-Sediment Accumulation Factors (BSAF) was a key component in a recent Superfund technology transfer document on use of fish tissue data to monitor remedy effectiveness.

Protecting America's waters is one of EPA's top priorities and efforts from the Land Research program contribute significantly to that effort. In FY 2011, the program will collaborate with the Great Lakes National Program Office (GLNPO) on science to develop alternative technologies for sediment remediation.

Additional planned research products for FY 2011 include key reports that will determine the degree of resuspended sediments from dredging and assess the significance of changes in bioavailability of organic and inorganic contaminants following resuspension and redeposition during dredging of contaminated sediments. Consistent with the National Research Council's report, "Sediment Dredging at Superfund Megasites: Assessing the Effectiveness,"[22] research will evaluate tools to assess remedy effectiveness using techniques such as:

- Passive samplers to measure bioaccumulation of persistent chemicals, BSAFs and PCB fish tissue models,
- Statistical methods to inform sampling for chemical and biological data, and
- Methods to assess remedy performance.

The Land Research program provides leadership in groundwater research to address fate, transport, and remediation issues. Research themes include characterization, analytical, and modeling methods to improve exposure estimates, and remediation technologies that include in-situ techniques, permeable reactive barriers (PRBs) for organic and metal contaminants, and monitored natural attenuation. Recent accomplishments in groundwater remediation research

[3] BOSC Land Restoration and Preservation Research Mid-Cycle Subcommittee Report. For more information, see http://www.epa.gov/osp/bosc/pdf/landmc0901rpt.pdf.

[22] For more information, see http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=11968

include research on the performance of PRBs as an alternative to traditional pump and treat methods. That research produced two key reports regarding application and performance of PRBs,[23] and application of this technology continues to occur at sites such as:

- ASARCO East Helena plant in Helena, Montana, where the application of PRBs results in the conversion and removal of mobile dissolved arsenic in groundwater, and
- Altus Air Force Base, Oklahoma, where PRBs replaced a failed pump and treat system, saving Air Force resources through the lifecycle of the clean up.

Research efforts also will address monitored natural attenuation, specifically in metal contaminated groundwater. The program published a key technical framework on monitored natural attenuation methods for inorganic contaminants, and the technology is being transferred to state remediation organizations. For organic contaminants, synthesis and state-of-the-science documents will provide EPA program offices, Regional Offices, and states with remediation technologies and long term stewardship for treatment of dense non-aqueous phase liquids, such as trichloroethylene, in groundwater. The transport of contaminants in groundwater and the subsequent intrusion of contaminant vapors into buildings is a critical research issue for EPA's Superfund remediation programs. Work is ongoing to provide vapor intrusion characterization, to develop reliable soil gas sampling methodologies, and to improve vapor intrusion modeling capability. In FY 2011, the research program will produce a comprehensive study looking at volatile organic compounds and radon concentration changes through a one year time frame.

Site characterization research under the Land Research program includes the development of analytical and statistical methods, field sampling guidance, statistical software, monitoring and remediation technologies for mining sites and technical support infrastructure needed to move the products of these research and development activities from the lab and into the hands of site managers and other decision makers. Recent accomplishments included a methodology that provides for potentially rapid analysis of various forms of polychlorinated biphenyls (PCBs). Additionally, in-situ chemical oxidation (ISCO) methods were applied to Superfund sites in Nebraska, where ISCO actively remediated the source area materials and groundwater. Application of this method reduced the remediation timeframe (compared to several other alternatives), had the least short term impacts on the community, and was cost effective. It will reduce the highest groundwater contaminant concentrations without the need for an operations and maintenance intensive treatment system. In FY 2011, research themes will include:

- The development and application of chemical and bio-analytical methods, and
- Development of statistical methods to reduce data uncertainty in measurement processes.

EPA has provided site-specific technical support to more than 100 cleanup program sites annually by responding to scientific questions (e.g., engineering and groundwater issues) and technology transfer products to EPA program offices and other stakeholders. Technical Support Centers provide information based on research results to increase the speed and quality of Superfund cleanups and reduce associated cleanup costs.

[23] For more information, see http://www.epa.gov/nrmrl/pubs/600r08093/600r08093.htm

EPA also will conduct research with an increased emphasis on asbestos health effects in order to develop data to support dosimetric and toxicologic assessment of amphibole asbestos fiber-containing material from Libby, Montana. This effort will address key data gaps and provide tools for quantitative characterization, including a comparative analysis of the toxicity of amphibole asbestos-contaminated vermiculite from Libby, Montana, relative to other asbestos fibers and asbestos-like mineral occurrences. Reports are scheduled for publication in FY 2011 on a field sampling device that may reduce the need for activity-based sampling at Libby and similar sites. One such report will include a manual for releasable asbestos field sampler testing for use on contaminated soil to determine if cleanup is needed.

Performance Targets:

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of Land publications in high impact journals.	No Target Established	Biennial	26.7	No Target Established	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of Land publications rated as highly cited publications.	No Target Established	Biennial	27.8	No Target Established	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of the manage material streams, conserve resources and appropriately manage waste long-term goal.	100	100	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of the mitigation, management and long-term stewardship of contaminated sites long-term goal.	100	100	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Ouput	Percentage of Land publications in high impact journals.	No Target Established	Biennial	26.7	No Target Established	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of Land publications rated as highly cited publications.	No Target Established	Biennial	27.8	No Target Established	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of the manage material streams, conserve resources and appropriately manage waste long-term goal.	100	100	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of the mitigation, management and long-term stewardship of contaminated sites long-term goal.	100	100	100	100	Percent

Work under this program supports EPA's Strategic Plan Objective 3.3: Enhance Science and Research. Specifically, the program provides and applies sound science for protecting and restoring land by conducting leading-edge research, which, through collaboration, leads to preferred environmental outcomes. In FY 2011, the program plans to accomplish its goals of completing and delivering 100 percent of its planned outputs. These measures address the increasing utility of EPA research tools and technologies, as well as the reduction of uncertainty due to utilization of research and development methodologies, models, and statistical designs. In achieving the performance targets, the program will contribute to EPA's goal of applying sound science in the protection and restoration of land.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$393.0) This reflects an increase for payroll and cost of living for existing FTE.

- (+$62.0) This represents a restoration of resources transferred in FY 2010 to the Research: Sustainability program to support Small Business Innovation Research (SBIR). For SBIR, EPA is required to set aside 2.5 percent of funding for contracts to small businesses to develop and commercialize new environmental technologies. After the FY 2011 budget is enacted, and the exact amount of the mandated requirement is known, FY 2011 funds will be transferred to the SBIR program.

- (+$25.0) This increase reflects the net result of realignments of resources such as critical equipment purchases and repairs, travel, contracts, and general expenses to better align with programmatic priorities. Realignments of these resources are based on FTE allocations as well as scientific equipment needs. This change reflects EPA's workforce management strategy that will help the Agency better align resources, skills and Agency priorities.

- (-$68.0) This decrease in travel costs reflects an effort to reduce the Agency's travel footprint by promoting green travel and conferencing.

- (-$2,534.0 \ -2.5 FTE) This reduction reflects a decrease in scope for planned research in groundwater remediation and contaminated sediments research, and includes a reduction of 2.5 FTE with decreased associated payroll of $337.0. This change reflects EPA's workforce management strategy that will help the agency better align resources, skills and Agency priorities.

Statutory Authority:

SWDA; HSWA; SARA; CERCLA; RCRA; OPA; BRERA.

Research: Land Protection and Restoration
Program Area: Research: Land Protection
Goal: Land Preservation and Restoration
Objective(s): Enhance Science and Research

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	$11,696.8	$14,111.0	$13,800.0	($311.0)
Leaking Underground Storage Tanks	*$424.1*	*$345.0*	*$457.0*	*$112.0*
Oil Spill Response	$382.8	$639.0	$689.0	$50.0
Hazardous Substance Superfund	$19,010.1	$21,191.0	$19,069.0	($2,122.0)
Total Budget Authority / Obligations	$31,513.8	$36,286.0	$34,015.0	($2,271.0)
Total Workyears	141.4	154.7	150.7	-4.0

Program Project Description:

Leaking Underground Storage Tank (LUST) research focuses on the assessment and cleanup of leaks at fueling stations, especially identifying the environmental impacts of existing and new biofuels coming into the marketplace. EPA's Land Research program provides the scientific foundation for the Agency's actions to protect America's land and ground water resources impacted by the nation's more than 600 thousand underground fuel storage tanks. The purpose of the Land Protection LUST research program is the prevention and control of pollution at LUST sites, and is of high importance to state environmental programs.

The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering. Specific activities in the LUST Land Research program include the development of source term and transport modeling modules for use by state project managers and the development of multiple remediation approaches applicable to spilled fuels, with or without oxygenates.

As the varieties of commercially used fuels increase, the Agency needs to:

- Determine how these new fuels affect the existing fueling station infrastructure,
- Determine ways to monitor potential leaks as a function of the infrastructure and fuel type, and
- Develop the risk management approaches to control and remediate these leaks to protect water supplies.

The Land Research program, in collaboration with the California Department of Health Services and the University of California, has demonstrated that ethanol in the fuel supply can result in

extended petroleum hydrocarbon plumes, increasing water supply vulnerability.[3] Overlaying this issue is the increase in water demands seen nationally, which has become more pronounced because of droughts experienced in many parts of the country. In areas with greater population density, there are a greater number of fueling stations and higher water demands to support the population. With the water utilities in these areas pumping more wells at a higher rate, combined with the potential for ethanol to expand the hydrocarbon plumes, leaks from underground storage tanks may impair or reduce the availability of drinking water supplies.

These research efforts are guided by the Land Multi-Year Plan (MYP)[4], developed with input from across the Agency, which outlines steps for meeting the needs of Agency programs and for evaluating progress through annual performance goals and measures. To enhance communication with customers, EPA developed a Land Research program Web site.[5] This site includes a description of the program; fact sheets (science issues, program research, and impacts); research publications and accomplishments; and links to tools and models.

FY 2011 Activities and Performance Plan:

In FY 2011, resources will continue to be utilized to address prevention and control. Underground storage tank research will focus more on biofuels, as increased ethanol and biodiesel use changes contaminant composition and susceptibility to remediation approaches. This goal is best achieved by proper characterization of both fuels and release sites, as well as the development of effective risk management approaches. Research activities will include:

- Fuels analysis, including understanding current and future shifts in supply.
- Understanding fate and transport of ethanol, biodiesel, and other biofuels coming into the marketplace using models that incorporate defining characteristics of the fuel and the releases.
- Work with the public and private sectors on analysis of infrastructure to determine vulnerabilities in the tank storage system to prevent water quality impairment.
- Technology transfer of a patented Biomass Concentrator Reactor for cost-effective treatment of ground water to remove contamination due to oxygenates, fuels, and fuel blends. Use of this reactor ensures that treated ground water meets established drinking water standards.
- Development of treatment options anticipating fuel composition changes and the nature of sites where releases will occur.
- Determining the role of vapor releases of gasoline from underground storage tanks on fuel constituent contamination in ground water both in the field and in laboratory settings.

This research will complement biofuels research conducted in the global change and air programs.

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[3] Mackay, D. M., N. R. de Sieyes, M. D. Einarson, K. P. Feris, A. A. Pappas, I. A. Wood, L. Jacobson, L. G. Justice, M. N. Noske, K. M. Scow and J. T. Wilson. Impact of Ethanol on the Natural Attenuation of Benzene, Toluene and o-Xylene in a Normally Sulfate-Reducing Aquifer. Environmental Science and Technology, 40:19, 6123-6130, 2006.

[4] EPA, Office of Research and Development, *Land Research Program MYP*. Washington, D.C.: EPA. For more information, see http://www.epa.gov/ord/htm/multi-yearplans.htm#land

[5] For more information, see www.epa.gov/landscience.

Performance Targets:

Work under this program supports EPA's Strategic Plan Objective 3.3: Enhance Science and Research. Specifically, the program provides and applies sound science for protecting and restoring land by conducting leading-edge research which, through collaboration, leads to preferred environmental outcomes. Performance measures for LUST research activities are included under the Superfund Land Protection and Restoration program.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$112.0) This reflects an increase for payroll and cost of living for existing FTE.

Statutory Authority:

BRERA; CERCLA; ERDDA; HSWA; OPA; RCRA; SARA; SWDA.

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	$11,696.8	$14,111.0	$13,800.0	($311.0)
Leaking Underground Storage Tanks	$424.1	$345.0	$457.0	$112.0
Oil Spill Response	*$382.8*	*$639.0*	*$689.0*	*$50.0*
Hazardous Substance Superfund	$19,010.1	$21,191.0	$19,069.0	($2,122.0)
Total Budget Authority / Obligations	$31,513.8	$36,286.0	$34,015.0	($2,271.0)
Total Workyears	141.4	154.7	150.7	-4.0

Program Project Description:

The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering. In the Oil Spill Research program, work focuses on three aspects:

- Protocol development for testing commercial product effectiveness;
- Understanding fate and transport of oil in the environment (such as the work done on bioremediation on shorelines and wetlands and dispersant research in a wave tank); and
- Spill response technology development.

EPA's Land Research program provides the scientific foundation for the Agency's actions to protect and sustain America's land. EPA develops and uses its protocols for testing various spill response product classes to pre-qualify products as outlined by the preparedness and response requirements of the Oil Pollution Act of 1990. Testing products ensures that they work as claimed and provides access to effective means to reduce damage when an oil spill occurs.

Spill response is a priority for the Agency, and EPA has been instrumental in providing guidance for various response technologies, such as the published bioremediation guidance documents[2]. A key factor in providing guidance on spill response technologies is developing a firm understanding of the science behind spill behavior in the environment. One example of why this understanding is required is to determine the cause of lingering oil in Prince William Sound twenty years after the Exxon Valdez spill. Fundamental science is essential to the development of effective regulations, and the Agency's oil spill research program has been invaluable in providing this guidance, as well as support for implementation, through activities such as annual On-Scene Coordinator training on alternative response technologies.

[2] For more information, see http://www.epa.gov/emergencies/publications.htm.

These research efforts are guided by the Land Research program's Multi-Year Plan (MYP)[3], developed with input from across the Agency. The MYP outlines steps for meeting the needs of Agency programs and for evaluating progress through annual performance goals and measures. To enhance communication with customers, EPA developed a Land Research program Web site.[4] The Web site includes a description of the program, fact sheets (science issues, program research, and impacts), research publications and accomplishments, and links to tools and models.

FY 2011 Activities and Performance Plan:

In FY 2011, the Land Research program will continue remediation research into advances associated with physical, chemical, and biological risk management methods for petroleum and non-petroleum oil and biofuel spills in freshwater and marine environments, as well as development of a protocol for testing oil solidifiers. This represents an additional spill cleanup technology with protocols developed by the Land Research program. Prior technologies include bioremediation agents, dispersants, and surface washing agents. The program also will develop testing guidelines that address environment, type of oil (petroleum oil, vegetable oil, animal fat, or biofuel), and agents for remediation. The program will continue to model the composition and properties of spilled oil, natural dispersion, emulsification, weathering, and effectiveness of control strategies. Research products are presented at meetings and posted or linked on EPA's oil spill Web site for use by oil spill managers.[5]

Performance Targets:

Work under this program supports EPA's Strategic Plan Objective 3.3: Enhance Science and Research. Specifically, the program provides and applies sound science for protecting and restoring land by conducting leading-edge research which, through collaboration, leads to preferred environmental outcomes. Performance measures for research activities in this program are included under the Superfund Land Protection and Restoration program.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$50.0) This reflects an increase for payroll and cost of living for existing FTE.

Statutory Authority:

SWDA; HSWA; SARA; CERCLA; RCRA; OPA; BRERA.

[3] EPA, Office of Research and Development, *Land Research Program MYP*. Washington, DC: EPA. For more information, see http://www.epa.gov/ord/htm/multi-yearplans.htm#land.
[4] For more information, see www.epa.gov/landscience.
[5] For more information, see http://www.epa.gov/oilspill/.

Homeland Security: Preparedness, Response, and Recovery

Program Area: Homeland Security
Goal: Clean Air and Global Climate Change
Objective(s): Healthier Outdoor Air; Radiation

Goal: Healthy Communities and Ecosystems
Objective(s): Chemical and Pesticide Risks; Enhance Science and Research

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Environmental Program & Management	$3,054.1	$3,423.0	$2,012.0	($1,411.0)
Science & Technology	*$41,771.8*	*$41,657.0*	*$34,598.0*	*($7,059.0)*
Hazardous Substance Superfund	$55,479.4	$53,580.0	$42,274.0	($11,306.0)
Total Budget Authority / Obligations	$100,305.3	$98,660.0	$78,884.0	($19,776.0)
Total Workyears	187.8	174.2	181.0	6.8

Program Project Description:

Through research, development, and technical support activities, EPA's Homeland Security Research Program (HSRP) enhances the Nation's preparedness, response, and recovery capabilities for homeland security large-scale catastrophic incidents involving chemical, biological, or radiological threats and attacks. The range of research programs and initiatives will both continue to develop a better understanding of the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering. EPA continues to evaluate tools and capabilities so that cost effective response and recovery approaches can be identified for future use by the response community, elected and appointed decision-makers, and risk managers. Research will further state-of-the-art approaches to address all phases of response and recovery to ensure public and worker safety, protect property, and facilitate recovery. The Agency also continues to work with other Federal agencies and organizations, through collaborative research efforts, to strengthen remediation and decontamination capabilities.

FY 2011 Activities and Performance Plan:

EPA homeland security research on chemical, biological, and radiological (CBR) contaminants will continue to fill critical gaps in our ability to effectively respond to and recover from threats and attacks, including large-scale catastrophic incidents. EPA has unique knowledge and expertise related to decontamination and disposal of contaminated materials. Additionally, the Agency has demonstrated results meeting the needs of decision-makers and responders across government and industry.

FY 2011 Homeland Security Research Program funds will be used to deliver science and engineering research results to the program's customers to better facilitate and enable their ability to carry out their homeland security missions. Customer needs, identified jointly, are the

primary consideration used in prioritizing research activities. Key customers include EPA's Water, Solid Waste and Emergency Response, and Air and Radiation programs, among others. EPA's research program provides support and assistance in interactions with water utilities to help ensure the nation's water systems are secure and drinking water is acceptable. The Agency's research program also is increasing its responsiveness to the science needs of the EPA response community (National Decontamination Team, Environmental Response Team, Radiological Emergency Response Team, Removal Managers, and On-Scene Coordinators). Research will focus on providing tools and support to facilitate response to and recovery from incidents involving CBR agents. Along with this customer focus, the program has enhanced communication throughout EPA's Homeland Security program and the Regional Offices to improve collaboration and to ensure that needs are met.

Decontamination Research:

EPA's decontamination research program directly supports the Agency's National Response Plan (NRP) as well as its homeland security responsibilities. In many cases, the research program also supports the Department of Homeland Security's needs for EPA expertise in a number of key areas including materials decontamination and disposal, threat assessment, and sampling and analytical methods. Activities in FY 2011 include the following:

- Threat and consequence assessment research will continue to focus on products and information to aid decision-makers in assessing risks to human health from biological and chemical agents and to further identify research gaps. EPA will collect, generate, and evaluate data on the toxicity, infectivity, mechanism of action, fate, transport, and exposure consequences for CBR contaminants. Data will be used to develop relationships of human response to varying doses of biological organisms to assist in the development of cleanup goals. Research will continue to identify risks during incidents and develop improved methods to communicate those risks to decision-makers and the public.

- Technology testing and evaluation research will continue to develop innovative methods and test commercially-available technologies. These efforts will enhance the Nation's ability to detect and decontaminate CBR contaminants resulting from terrorist attacks on infrastructure and outdoor areas such as urban centers.

- Response capability enhancement research will continue to support the development of the Environmental Response Laboratory Network (ERLN). EPA will continue to expand the Standardized Analytical Methods (SAM) and create Reference Laboratory capability. SAM identifies high risk CBR agents and analytical methods for the ERLN that are required to characterize the nature and extent of contamination and document restoration. Reference Laboratories serve as an authoritative source in the ERLN for method development, verification, and validation.

- Decontamination and consequence management research will continue to develop and improve decontamination and disposal techniques and technologies for CBR contaminants. This research includes the remediation and clean-up of building exteriors

and infrastructure (e.g., subways, bridges, stadiums, airports, train stations, rail lines, highways, drinking water and wastewater systems). It also involves the clean-up of various outdoor areas (e.g., walks, streets, parks) in both urban and non-urban areas, as well as the safe disposal of contaminated materials and decontamination residue.

Decontamination research will produce many science and engineering products in FY 2011 to support EPA's National Response Plan and first responders in carrying out their homeland security missions. The following are several key activities to be completed in FY 2011:

- Development and verification of analytical and sampling methods for CBR agents in the environment.
- Development of health-based Provisional Advisory Levels (PALs) for 12 chemical agents to guide responders on human health risk of exposure to toxic industrial chemicals and chemical warfare agents. PALs apply to exposure durations ranging from 24 hours to two years. They complement the Acute Exposure Guidelines Levels (AEGLs) program, which derives limits for exposure durations of up to eight hours.
- Understanding outdoor surface deposition, adhesion, and reaerosolization of anthrax.
- Evaluation of techniques for decontaminating surfaces contaminated with ricin.
- Evaluation of technologies for decontamination of building materials contaminated by radiological agents.
- Evaluation of background soil concentration ranges of anthrax in U.S. soils.
- Summary of work on the use of spray technologies for decontamination of chemical agent contaminated surfaces.

Water Infrastructure Protection Research:

Water Infrastructure Protection Research will focus on developing, testing, demonstrating, communicating, and implementing enhanced methods for detection, treatment, and containment of CBR agents and bulk industrial chemicals intentionally introduced into drinking water and wastewater systems. This is consistent with the Critical Infrastructure Protection Plan (CIPP), developed for water infrastructure, and with the Water Security Research and Technical Support Action Plan. The program will produce many science and engineering products in FY 2011 to support EPA's Water Program and water utilities in carrying out their homeland security missions. The following are several key activities to be completed in FY 2011:

- Determination of the persistence of contaminants in drinking water distribution systems and the effectiveness of decontamination techniques.
- Evaluation of methods to contain and treat wastewater generated from decontamination efforts and assess requirements for its discharge to treatment works or water bodies.
- Development of decontamination protocols and technologies for drinking water and wastewater systems.
- Determination of the impacts of flushing water infrastructure following contamination.
- Update of the Blast Vulnerability Assessment Model to include underground storage tanks.

Radiation Monitoring:

Maintenance of the RadNet air monitoring network supports EPA's responsibilities under the Nuclear/Radiological Incident Annex to the National Response Framework (NRF). The network includes deployable monitors and near real-time stationary monitors.

Through FY 2010, EPA expects to install at least 134 monitors providing near real-time radiation monitoring coverage for each of the 100 most populous U.S. cities as well as expanded geographic coverage. In FY 2011, the Agency will maintain the expanded RadNet air monitoring network. These near real-time monitors replaced or augmented the pre-existing system of 60 conventional air samplers. Fixed stations will operate routinely and in conjunction with as many as 40 deployable monitors following a radiological incident. With the expanded RadNet air monitoring network, average response time and data dissemination will be reduced from days to hours and will provide the Agency and first responders with greater access to data, improving officials' ability to make decisions about protecting public health and the environment during and/or after an incident. Additionally, the data will be used by scientists to better characterize the effect of a radiological incident.

Biodefense:

EPA will focus on filling critical gaps in microbial resistance, efficacy test protocols for decontamination products, and decontamination tool boxes for bioterrorism agents.

Performance Targets:

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of efficient and effective clean-ups and safe disposal of contamination wastes.	100	85	100	80	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of water security initiatives.	100	100	100	80	Percent

Unassociated with the proposed reduction in funding, the Homeland Security Program will be piloting an effort to set more ambitious performance targets. The program is expanding the scope and ambitiousness of research to be completed each year in order to speed the delivery of that research to decision-makers. Setting stretch goals that will result in achieving 80-90% performance levels will provide program managers more meaningful information to manage and improve program performance over time.

Work under this program supports multiple strategic objectives. In FY 2011, the program plans to meet its targets of completing and delivering planned outputs in support of: 1) the efficient and effective cleanup and safe disposal of decontamination wastes, 2) the Water Security Initiative, 3) the rapid assessment of risk and the determination of cleanup goals and procedures following contamination, 4) the National Laboratory Response Network, and 5) the validation of standardized methods for evaluating the efficacy of antimicrobial products against a variety of biological pathogens. In achieving these targets, the program will contribute to EPA's goal of providing scientifically sound guidance and policy decisions related to the health of people, communities, and ecosystems.

EPA is on track through its ongoing work to meet its FY 2011 strategic plan goal of protecting public health and the environment from unwanted releases of EPA-regulated radioactive waste and to minimize impacts to public health from radiation exposure. In addition, the program developed an efficiency measure that demonstrates that the program utilizes total resources efficiently.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$1,526.0) This reflects an increase for payroll and cost of living for existing FTE.
- (-$5.0) This reflects adjustments to IT and telecommunications resources. Realignment of these resources is based on FTE allocations.
- (-$78.0) This decrease in travel costs reflects an effort to reduce the Agency's travel footprint by promoting green travel and conferencing.
- (-$190.0 / -2.6 FTE) This reflects the net result of realignments of FTE and resources such as critical equipment purchases and repairs, travel, contracts, and general expenses to better align with programmatic priorities. These realignments are based on FTE allocations as well as scientific equipment needs.
- (-$1,449.0) This change reflects a shift of resources for the Agency's water security and decontamination research activities. The extramural dollars reflect the transfer of extramural funding to payroll.
- (+10.0 FTE) The change reflects EPA's workforce management strategy that will help the Agency better align resources, skills, and Agency priorities. FTE will assist in water security and decontamination efforts.
- (-$4,009.0 / -0.6 FTE) This reflects a reduction in the areas of water security, threat and consequence assessment, and safe buildings research due to the decreasing need for Water Security Initiative modeling support and a shift in focus to higher priority Agency needs.

- (-$1,764.0) This reflects decreased support for homeland security pesticides activities due to substantial development and validation of methods to evaluate the efficacy of antimicrobial products against bioterrorism agents.

- (-$499.0) This reflects a reduction to audits and training to support national radiological laboratory capacity and capability as the Agency focuses on higher priority areas.

- (-$591.0) This reflects a reduction for EPA's RadNet national environmental radiation monitoring network as expansion of RadNet's geographic coverage to include the most at-risk populations is complete.

Statutory Authority:

Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011 et seq. (1970), and Reorganization Plan #3 of 1970; CAA; CERCLA; SARA; Executive Order 12241 of September 1980, National Contingency Plan, 3 CFR, 1980; Executive Order 12656 of November 1988, Assignment of Emergency Preparedness Responsibilities, 3 CFR, 1988; Public Health Service Act, as amended, 42 U.S.C. 201 et seq.; Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended, 42 U.S.C. 5121 et seq.; SDWA; Title XIV of the National Defense Authorization Act of 1997, PL 104-201 (Nunn-Lugar II) National Response Plan; Public Health Security and Bioterrorism Emergency and Response Act of 2002; TSCA; Oil Pollution Act; Pollution Prevention Act; RCRA; EPCRA; CWA; FIFRA; Federal Food, Drug and Cosmetic Act; FQPA; Ocean Dumping Act; Public Health Service Act, as amended; 42 U.S.C. 201 et seq.; Executive Order 10831 (1970); Public Law 86-373; PRIA.

Homeland Security: Preparedness, Response, and Recovery
Program Area: Homeland Security
Goal: Land Preservation and Restoration
Objective(s): Restore Land

Goal: Healthy Communities and Ecosystems
Objective(s): Enhance Science and Research

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Environmental Program & Management	$3,054.1	$3,423.0	$2,012.0	($1,411.0)
Science & Technology	$41,771.8	$41,657.0	$34,598.0	($7,059.0)
Hazardous Substance Superfund	*$55,479.4*	*$53,580.0*	*$42,274.0*	*($11,306.0)*
Total Budget Authority / Obligations	$100,305.3	$98,660.0	$78,884.0	($19,776.0)
Total Workyears	187.8	174.2	181.0	6.8

Program Project Description:

EPA's Homeland Security Emergency Preparedness and Response program develops and maintains an Agency-wide capability to respond to large-scale catastrophic incidents with emphasis on those that may involve Weapons of Mass Destruction (WMD). The program builds upon EPA's long standing emergency response and removal program, which is responsible for responding to and cleaning up both oil and hazardous substance releases. EPA's homeland security effort expands these responsibilities to include threats associated with chemical, biological, and radiological (CBR) agents. To meet this challenge, EPA will continue to use a comprehensive approach that brings together all emergency response assets to implement efficient and effective responses. Another priority for this program is improving research, development, and technical support for potential threats and response protocols. The range of research programs and initiatives will both continue to develop a better understanding of the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering.

FY 2011 Activities and Performance Plan:

In FY 2011, efforts to develop the capability to respond to multiple incidents will concentrate on four core areas: 1) maintaining a highly skilled, well-trained, and equipped response workforce that has the capacity to respond to simultaneous incidents as well as threats involving WMD substances; 2) developing decontamination options, methods, and protocols to ensure that the nation can quickly recover from nationally significant incidents; 3) ensuring that current laboratory equipment maintains the capability to analyze Chemical Warfare Agent (CWA) fixed and mobile samples while continuing to leverage other agencies for biological agent analyses; and 4) implementing the EPA's National Approach to Response (NAR) to effectively manage EPA's emergency response assets during large-scale activations. The decrease in resources in FY 2011 is not expected to impede efforts to meet agency goals under this program.

EPA activities in support of these efforts include the following:

- Maintain the skills of EPA's On-Scene Coordinators (OSCs) through specialized training, exercises, and equipment. In FY 2011, EPA and its Federal, state, local, and Tribal homeland response partners will continue to participate in exercises and trainings designed to test and improve EPA's response capabilities.

- Develop the Agency's responder base during large-scale catastrophic incidents by training volunteers of the Response Support Corps (RSC) and members of Incident Management Teams (IMTs). These volunteers provide critical support in Headquarters and Regional Emergency Operations Centers and in assisting with operations in the field. To ensure technical proficiency, this cadre of response personnel requires initial training and yearly refresher training to include opportunities to participate in exercises. Depending upon the level and complexity of the assigned position, volunteers may also participate in workshops, health and safety training, medical monitoring, and equipment acquisition, as necessary. The focus is on their assigned responsibilities during a response, interactions with the emergency response program personnel, and understanding lines of communication within an IMT.

- Ensure that laboratories maintain the capacity and capability to analyze and verify CWA samples during nationally significant incidents. The Agency also will maintain and operate existing fixed CWA labs and develop the capability of two Portable High-Throughput Integrated Laboratory Identification Systems (PHILIS) units. The Agency will continue to participate with the Integrated Consortium of Laboratory Networks, maintaining a laboratory compendium of Federal, state, and commercial capabilities, and maintain a chemical surety program.

- Establish agreements with other Federal agencies to access biological warfare agent laboratory analyses.

- Operate the Environmental Response Laboratory Network (ERLN) in Headquarters and Regional Offices to provide lab analysis for routine and emergency response and removal operations, including a terrorist attack.

- Continue to develop and validate environmental sampling, analysis, and human health risk assessment methods for known and emerging biological threat agents. These sampling and analysis methods are critical to ensuring appropriate response and recovery actions and developing necessary laboratory support capacity. The human health risk assessment methods are also extremely important to decision-makers who are faced with determining when decontaminated facilities and equipment can be returned to service. This decontamination and consequence management research will produce data, information, and technologies to assist EPA in developing standards, protocols, and capabilities to recover from and mitigate the risks associated with biological attacks.

- Implement the NAR to maximize regional interoperability and to ensure that EPA's OSCs will be able to respond to terrorist threats and large-scale catastrophic incidents in an effective and nationally consistent manner.

- Continue to maintain one Airborne Spectral Photometric Environmental Collection Technology (ASPECT) aircraft. The EPA ASPECT provides direct assistance to first responders by remotely detecting chemical and radiological vapors, plumes, and clouds.

- Maintain the Emergency Management Portal (EMP) modules. EMP ties together prevention, preparedness, and response information to allow EPA's emergency management community access to information they need to respond to and efficiently store data from large and small sites. The Decontamination Portfolio resides in the EMP.

- Conduct WMD decontamination course for EPA OSCs, Special Teams, and RSC personnel to improve decontamination preparedness for CBR agents.

- The Environmental Response Team (ERT) will maintain personnel and equipment in a state of readiness for response to potential homeland security incidents. It also will maintain capacity to provide required health and safety and response readiness training.

Performance Targets:

Work under this program supports multiple strategic objectives. Currently, there are no performance measures for this specific Program Project.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (-$31.0) This reflects a reduction for payroll and cost of living for existing FTE.

- (-$289.0) This decrease in travel costs reflects an effort to reduce the Agency's travel footprint by promoting green travel and conferencing.

- (-$11,000.0) This reduction reflects completion of ramp up of recent Agency investments in homeland security emergency preparedness and response activities, such as laboratory and decontamination preparedness.

- (+$14.0) This reflects the net result of realignments of resources such as critical equipment purchases and repairs, travel, contracts, and general expenses to better align with programmatic priorities. These realignments are based on FTE allocations as well as scientific equipment needs.

Statutory Authority:

CERCLA Sections 104, 105, 106; Clean Water Act; Oil Pollution Act.

Human Health Risk Assessment
Program Area: Research: Human Health and Ecosystems
Goal: Healthy Communities and Ecosystems
Objective(s): Enhance Science and Research

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	*$41,478.1*	*$44,789.0*	*$45,626.0*	*$837.0*
Hazardous Substance Superfund	$3,776.4	$3,404.0	$3,350.0	($54.0)
Total Budget Authority / Obligations	$45,254.5	$48,193.0	$48,976.0	$783.0
Total Workyears	197.0	188.6	202.8	14.2

Program Project Description:

Human health risk assessment is a process where information is analyzed to determine if an environmental hazard might cause harm to exposed persons (National Research Council, 1983). EPA's Human Health Risk Assessment (HHRA) program generates health assessments that are used extensively by EPA Program and Regional Offices and other parties to determine the potential risk to public health from exposure to environmental contaminants to develop regulatory standards, and to manage environmental cleanups. The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering.

EPA's human health risk assessment program provides the scientific foundation for the Agency's actions to protect Americans' public health and the environment and supports the Administrator's priorities for improving air quality, assuring the safety of chemicals and protecting America's waters. Three complementary areas comprise the Human Health Risk Assessment program:

1) The Integrated Risk Information System (IRIS) and other priority health assessments;
2) Risk assessment guidance, methods, and model development; and
3) Integrated Science Assessments (ISA) of criteria air pollutants.

IRIS and other health hazard assessments: Peer reviewed, qualitative and quantitative health hazard assessments are prepared on environmental pollutants of major relevance to EPA's regulatory mandates. These assessments are used by EPA's Program and Regional Offices to support their decision making and also are disseminated to the public on the IRIS internet database.[30] IRIS is widely used throughout EPA and the risk assessment/risk management community as the premier source of hazard and dose-response information for environmental pollutants. As of January 2010, more than 550 health hazard assessments were available through IRIS.

30 Available at: http://www.epa.gov/iris.

Methods, Models and Approaches to Improve Risk Assessment Science: Risk assessment approaches, methods, and models are needed to enhance the quality and objectivity of assessments through the incorporation of contemporary scientific advances. These developments are often first used in the development of IRIS assessments and ISAs. However, they often support decision making by EPA's Program and Regional Offices as well. These scientific products are externally peer reviewed and disseminated through the published literature and EPA Web sites.

Integrated Science Assessments: Congress requires that EPA regularly summarize the state-of-the-science for criteria air pollutants—ozone, particulate matter, sulfur and nitrous oxides, carbon monoxide, and lead—to assist EPA's Air and Radiation program in determining the National Ambient Air Quality Standards (NAAQS). These integrated science assessments (formerly Air Quality Criteria Documents) are major risk assessments that undergo rigorous external peer review by the Clean Air Scientific Advisory Committee (CASAC).

This research program is guided by the Human Health Risk Assessment Multi-Year Plan[31] (MYP), which details the products planned under this program. The MYP also outlines research needs and priorities for making decisions central to EPA's implementation of its statutory responsibilities and in its mission to protect human health and the environment. Performance outputs and outcomes are documented in the MYP and are linked to the program's annual and long-term performance measures. The MYP also outlines coordination efforts with a number of EPA research strategies and plans[32] (*e.g.,* Human Health Research Strategy, Drinking Water MYP, Clean Air MYP) to obtain the information necessary to inform risk assessment outputs and programmatic decisions.

In FY 2008, an evaluation by EPA's Board of Scientific Counselors (BOSC)—a Federal advisory committee composed of independent expert scientists and engineers—concluded that the Human Health Risk Assessment program "has been highly responsive to the needs of the program offices and regions," producing products that are critical to EPA's regulatory mission and forming the foundation for regulatory decisions and policies. This prospective and retrospective review evaluated the program's relevance, quality, performance, and scientific leadership. The evaluation found that the program is making substantial and satisfactory progress, has clearly defined milestones and provides additional essential support to EPA programs to respond to unscheduled emergency needs. The BOSC's evaluation and recommendations are being used to help plan, implement, and strengthen the program over the next five years. In mid 2010, the BOSC will review the progress of the HHRA program in implementing its previous recommendations.

FY 2011 Activities and Performance Plan:

In FY 2011, EPA requests $29.4 million to continue to develop IRIS and other health hazard assessments. EPA will continue to evaluate the implementation of the new IRIS process over time. This will address concerns and recommendations in the Government Accountability Office's (GAO) High Risk Series report identifying weaknesses in the IRIS process to ensure

31 Available at: http://www.epa.gov/ord/htm/multi-yearplans.htm

32 Available at: http://www.epa.gov/ord/htm/researchstrategies.htm and http://www.epa.gov/ord/htm/multi-yearplans.htm.

that the program effectively meets the needs of EPA, the Federal government, and the American public.

In the area of risk assessment guidance, methods and models, the Agency requests $9.4 million in FY 2011. This continued investment will make improvements in the following areas:

- Applying mode of action information in risk assessments;
- Characterizing risks to susceptible populations;
- Characterizing environmental exposures for use in risk assessments;
- Improving quantification of health risks (e.g., PBPK and BBDR modeling, categorical regression, meta analysis approaches);
- Improving characterization of variability and uncertainty analysis in risk assessment; and
- Applying cumulative risk assessment principles to health assessments

In addition, EPA requests $6.8 million in FY 2011 for the Human Health Risk Assessment program to continue to conduct Integrated Science Assessments (ISAs). In FY 2011, the program will:

- Continue to improve and implement a process to identify, compile, characterize, and prioritize new scientific studies for ISAs of criteria air pollutants, as a mandated prerequisite to EPA's review of the NAAQS and effectively meet court ordered deadlines to provide these assessments; and
- Release external review draft ISAs for ozone and lead to contribute to EPA's Office of Air and Radiation's review of the NAAQS and creation of state-of-the-science methods for continuous evaluation of assessments of new scientific information on criteria air pollutants.

These continued investments will allow the Human Health Risk Assessment program to make significant progress toward its long-term goals of providing state-of-the-science health hazard assessment information. The ISAs provide important scientific analytics in support of many of EPA's important rulemakings.

The Human Health Risk Assessment program is taking a number of steps to further improve productivity including revising management controls to better incorporate both programmatic priorities and the level of effort required to increase the number of IRIS assessments completed each year; implementing new performance measures to improve performance management; and investigating alternative approaches for measuring progress related to providing timely, high quality scientific assessments.

Performance Targets:

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of HHRA Technical Support Documents.	90	100	90	90	Percent

The research conducted under this program supports EPA Strategic Objective 4.4. Specifically, the program identifies and synthesizes the best available scientific information, models, methods, and analyses to support Agency guidance and policy decisions related to the health of people and communities.

The program gauges its annual and long term success in meeting this objective by assessing its progress on several key measures. The program continues to track the percent completion of key milestones, including the on-time delivery of HHRA health assessments and technical support documents. The current IRIS process was streamlined in 2009 in response to GAO recommendations and the program's newest measures will be formalized and the targets for outputs adjusted accordingly.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$601.0) This reflects an increase for payroll and cost of living for existing FTE.

- (+$255.0) This represents a restoration of resources transferred in FY 2010 to the Research: Sustainability program to support Small Business Innovation Research (SBIR). For SBIR EPA is required to set aside 2.5 percent of funding for contracts to small businesses to develop and commercialize new environmental technologies. After the FY 2011 budget is enacted, when the exact amount of the mandated requirement is known, FY 2011 funds will be transferred to the SBIR program.

- (-$76.0) This decrease in travel costs reflects an effort to reduce the Agency's travel footprint by promoting green travel and conferencing.

- (-$410.0 \ -0.9 FTE) This decrease reflects a minor reduction of resources in support of risk assessment research and includes decreased associated payroll of $128.0. It will delay some work addressing benchmark dose software updates. This change reflects EPA's workforce management strategy that will help the Agency better align resources, skills and Agency priorities.

- (+$483.0 \ +1.1 FTE) This reflects the net result of realignments of FTE and resources such as critical equipment purchases and repairs, travel, contracts, and general expenses to better align with programmatic priorities, including 1.1 FTE with associated payroll of $156.0. Realignments are based on FTE allocations as well as scientific equipment needs.

- (-$16.0 \ +14.0 FTE) This FTE increase supports development of Integrated Science Assessments (ISAs) and strengthens the Agency's work on addressing risk assessment methods, a top priority for the Administration, and includes 14.0 FTE with associated payroll of $1,988.0. In addition, $2,011.0 in extramural funds are redirected to payroll to support these critical risk assessment FTE. This represents an on-going realignment of administrative FTE to meet court-ordered NAAQS deadlines.

Statutory Authority:

CAA; SDWA; CWA; TSCA; FIFRA; CERCLA; SARA; FQPA; ERDDA.

Human Health Risk Assessment

Program Area: Research: Human Health and Ecosystems
Goal: Healthy Communities and Ecosystems
Objective(s): Enhance Science and Research

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	$41,478.1	$44,789.0	$45,626.0	$837.0
Hazardous Substance Superfund	*$3,776.4*	*$3,404.0*	*$3,350.0*	*($54.0)*
Total Budget Authority / Obligations	$45,254.5	$48,193.0	$48,976.0	$783.0
Total Workyears	197.0	188.6	202.8	14.2

Program Project Description:

The Human Health Risk Assessment (HHRA) program provides health hazard assessments and develops assessment methods. The program, which receives resources under both the Science and Technology and the Superfund appropriations, provides the scientific foundation for the Agency's actions to protect Americans' public health and the environment and supports the Administrator's priorities for improving air quality, assuring the safety of chemicals and protecting America's waters. The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering.

Risk assessments and methodologies to support EPA's Superfund program are detailed in the HHRA Multi-Year Plans (MYPs)[16]. This risk assessment work is informed by EPA's superfund research program. This superfund research is described in the *Waste Research Strategy*[17], which was developed with participation from major clients and stakeholders and outlines research needs and priorities. Developed with input from across the Agency, including scientific staff in the Superfund program and the Regional Offices, the MYPs outline steps for meeting the needs of Agency programs and for evaluating progress through annual performance goals and measures.

A subcommittee review from the Board of Scientific Counselors (BOSC)—a Federal advisory committee composed of qualified, independent scientists and engineers—found that the National Center for Environmental Assessment (NCEA) had made several key advancements including completion of a strategic plan, targeting cutting-edge risk assessments, enhancing communication, and improving capabilities to provide assessment resources in response to significant events. A subsequent BOSC subcommittee program review was completed in April 2008. This prospective and retrospective review evaluated the program's relevance, quality, performance, and scientific leadership. The BOSC reported that the HHRA program is making

[17] U.S. EPA, Office of Research and Development, *Waste Research Strategy*. Washington, D.C.: EPA. For more information, see http://www.epa.gov/ord/htm/documents/wastepub.pdf.

substantial and satisfactory progress in each of the above areas based both on clearly defined milestones as well as additional support requested by EPA programs including technical support in response to unscheduled emergency needs. The BOSC's evaluation and recommendations provided guidance to EPA to help plan, implement, and strengthen the program. In mid 2010, the BOSC will review the progress HHRA has made in implementing its planned research as well as previous BOSC recommendations.

The Superfund portion of the program includes the following:

- The Integrated Risk Information System (IRIS)[18], Provisional Peer-Reviewed Toxicity Values (PPRTVs), and other health hazard assessments (FY 2011 Request, $2.3 million). Based on the expressed needs of EPA's Solid Waste and Emergency Response program, the Human Health Risk Assessment program prepares IRIS hazard characterization and dose-response profiles for environmental pollutants of specific relevance to Superfund site assessments and remediation. As of January 2010, more than 550 health hazard assessments were available through IRIS, and the majority of these chemicals assessments are relevant to Superfund's decision making. Where IRIS values are unavailable, the HHRA program develops PPRTVs for evaluating chemical specific exposures at Superfund sites. Support for these PPRTV assessments is provided through EPA's Superfund Technical Support Centers. As of January 2010, new or renewed PPRTVs had been developed for 236 chemicals.

- Risk assessment guidance, methods, and model development (FY 2011 Request, $1.0 million). As part of the Human Health Risk Assessment program's broader efforts to improve risk assessment guidance, methods, and models, Superfund resources support EPA's Superfund program through the development of exposure-response data arrays, revised reference concentration (RfC) methodology and cumulative risk tools to better estimate potential effects of exposures at Superfund sites on humans, and the consultative support necessary for the application of these methods.

FY 2011 Activities and Performance Plan:

In FY 2011, the HHRA program will continue to directly support key elements of EPA's Strategic Plan relating to Superfund—particularly the characterization of risks, reduction of contaminant exposures, and cleanup of contaminated sites. Risk assessment activities relevant to Superfund cleanups will include:

- Continuing to work toward the completion of IRIS health hazard assessments for high priority chemicals found at multiple Superfund sites and thereby contributing to decision-making needs for Superfund and other Agency programs (also supported by HHRA under the Science and Technology appropriation);

- Completing 50 new or renewed Provisional Peer Reviewed Toxicity Values (PPRTV) which consist of provisional reference doses/concentrations (pRfD/Cs), and/or cancer slope factors. The Solid Waste and Emergency Response program develops and

[18] Available at: http://www.epa.gov/iris.

prioritizes requests for these PPRTV's, which provide health hazard evaluations for priority pollutants to support Agency risk management decisions;

- Communicating results of peer reviewed publications on methods and tools for assessing cumulative risk (also supported by HHRA under the Science and Technology appropriation); and

- Continuing to provide technical support to Superfund site and program managers on human health risk assessment through the Superfund Technical Support Centers.

The BOSC's independent evaluations have found that PPRTVs have substantial value even beyond their immediate purpose of supporting Superfund assessments and remediation, e.g., "In the absence of IRIS values for a chemical, PPRTVs can have a significant impact on regulatory decisions." To further strengthen program impact, HHRA is revising its management controls to better incorporate both programmatic priorities and the level of effort required to increase the number of IRIS assessments completed each year; implementing new performance measures to improve performance management; and investigating alternative approaches for measuring progress related to providing timely, high quality scientific assessments.

Performance Targets:

The research conducted under this program supports EPA Strategic Objective 4.4. Specifically, the program identifies and synthesizes the best available scientific information, models, methods, and analyses to support Agency guidance and policy decisions related to the health of people and communities.

A performance measure for research activities in this program is included under the Science and Technology Human Health Risk Assessment program. The program gauges its annual and long-term success in meeting this objective by assessing its progress on several key measures. The program continues to track the percent completion of key milestones, including the on-time delivery of HHRA health assessments and technical support documents. The current IRIS process was streamlined in 2009 in response to GAO recommendations and the program's newest measures will be formalized and the targets for outputs adjusted accordingly.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$12.0) This represents a restoration of resources transferred in FY 2010 to the Research: Sustainability program to support Small Business Innovation Research (SBIR). For SBIR, EPA is required to set aside 2.5 percent of funding for contracts to small businesses to develop and commercialize new environmental technologies. After the FY 2011 budget is enacted, and the exact amount of the mandated requirement is known, FY 2011 funds will be transferred to the SBIR program.

- (-$6.0) This decrease in travel costs reflects an effort to reduce the Agency's travel footprint by promoting green travel and conferencing.

- (-$20.0) This decrease is the net effect of increases for payroll and cost of living for existing FTE, combined with a reduction based on the recalculation of base workforce costs.

- (-$40.0) This reflects the net result of adjustments for critical equipment purchases, repairs, travel, contracts, and general expenses resulting from FTE realignments. Realignments are based on FTE allocations as well as scientific equipment needs.

Statutory Authority:

SWDA; HSWA; SARA; CERCLA; ERDDA.

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	*$13,710.1*	*$20,048.0*	*$21,855.0*	*$1,807.0*
Total Budget Authority / Obligations	$13,710.1	$20,048.0	$21,855.0	$1,807.0
Total Workyears	36.9	32.7	34.6	1.9

Program Project Description:

Computational Toxicology is the application of mathematical and computer models to help assess the hazards and risk chemicals pose to human health and the environment. Supported by advances in informatics, high-throughput screening, and genomics, computational toxicology offers scientists the ability to develop a more detailed understanding of the risks posed by large numbers of chemicals, while at the same time reducing the use of animals for toxicological testing.

EPA is developing robust and flexible computational tools that can be applied to the thousands of contaminants and contaminant mixtures found in America's air, water, and hazardous-waste sites in support of the Administrator's priorities for improving air quality, assuring the safety of chemicals, cleaning up our communities and protecting America's waters. The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering.

Established in 2003, EPA's Computational Toxicology Research program (CTRP) has the longterm goal of improving understanding about the relationship of sources of chemicals in the environment and their potential to cause adverse health effects by providing tools for screening for exposures and hazards and prioritizing chemicals for additional follow up assessments. The National Center for Computational Toxicology, established in 2005, comprises the largest component of the CTRP. Research under this program is also conducted through EPA's Science to Achieve Results (STAR) grant program and other EPA laboratories. The strategic directions of the CTRP are highly consistent with the National Research Council report "Toxicity Testing in the Twenty-first Century: A Vision and a Strategy"[33] (Tox21), and include several substantial and innovative projects in chemical screening and prioritization, informatics, and systems biology[34]. The tools are transforming environmental health protection by providing risk assessors and managers more efficient and effective methods for managing chemical risks.

[33]Toxicity Testing in the Twenty-first Century: A Vision and a Strategy
http://dels.nas.edu/dels/rpt_briefs/Toxicity_Testing_final.pdf
[34] http://www.epa.gov/ncct/pdf/ORD_NCCT_Imp_Plan.pdf

The contribution of the STAR program to the CTRP includes two centers in bioinformatics and two in computational toxicology. The bioinformatics centers will have completed their work by FY 2011. The newest STAR computational toxicology center focuses on developmental toxicity. The research of these centers will help fill gaps in our understanding of the molecular pathways that may result in toxicity to the developing embryo and fetus, which we know represent highly susceptible life stages to chemical exposure. As these pathways are identified, assays will be developed to test their sensitivity to thousands of chemicals.

Partnering With Others

All of these CTRP efforts are coordinated with other Federal partners through the Tox21 initiative in order to hasten this transformation in environmental health protection[35]. The CTRP efforts are also at the core of *The U.S. Environmental Protection Agency's Strategic Plan for Evaluating the Toxicity of Chemicals*[36]. The *Strategic Plan* and the CTRP Implementation Plan for FY 2009-2012 highlight the unique capabilities of EPA to provide the necessary science to transform how chemical and other risk assessments are performed, and thus support improved management of environmental contaminants and chemical risk.

Scientific review of the CTRP is conducted by EPA's Board of Scientific Counselors (BOSC), a Federal Advisory Committee composed of independent expert scientists and engineers. The fourth review of the CTRP by the BOSC subcommittee occurred in late 2009. The draft report for this review will be vetted by the BOSC Executive Committee at their meeting in February 2010.

FY 2011 Activities and Performance Plan:

The CTRP Implementation Plan will focus on three key areas in FY 2011:

- Chemical prioritization and categorization tools;
- Information technology; and
- Systems biology models under a unified long term goal of providing high-throughput decisions support tools for chemical exposure, as well as hazard and risk assessment to EPA's regulatory program offices.

Chemical Prioritization and Categorization Tools

Managing the risks from toxic chemicals in the environment to protect human health is a top priority for EPA. Given the thousands of chemicals in use, to achieve this goal the Agency must continue improving its capability to predict which chemicals present the greatest risk and are in need of toxicology testing, and which endpoints would be the most important to examine. To address this need, in FY 2007, EPA launched its ToxCast™ research program, which employs new automated laboratory methods, developed by the pharmaceutical industry, to test chemicals for their impacts on cell function in less time and for less cost than animal studies. This "high-throughput screening" enables testing on a backlog of chemicals that have not previously been tested, or have not been thoroughly tested, to determine if they are toxic to humans or the environment.

[35] Collins et al., 2008, *Science;* http://www.sciencemag.org/cgi/reprint/319/5865/906.pdf
[36] National Service Center for Environmental Publications P.O. Box 42419 Cincinnati ,OH 45242 # 100K09001

In Phase I of ToxCast™, the Agency obtained high-throughput screening data on 320 chemicals with known toxicological profiles. More than 600 endpoints for each chemical were obtained using high-throughput screening assays. Data collection for Phase I was completed in FY 2009, although analysis of the unique data resource continues. ToxCast™ efforts have been expanded by EPA partnerships with NIH via the Tox21 collaboration. The Tox21 partnership brings together the hundreds of ToxCast™ assays, with the thousands of chemicals being tested at the NIH Chemical Genomics Center[37].

Phase II of ToxCast consists of efforts to profile the activities of up to 700 additional compounds in order to broaden the diversity of chemicals tested and evaluate the predictive nature of bioactivity signatures. One unique aspect of Phase II is a partnership with Pfizer that will provide more than 100 chemicals proven toxic to humans in clinical trials. This information will allow for direct comparison of ToxCast™ results with effects in humans. With successful completion of Phase II (scheduled for FY 2012), ToxCast™ technologies can be applied to chemicals and other materials of concern to EPA program offices (e.g. nanomaterials).

In FY 2011, the CTRP will increase funding for research using next-generation tools to speed and facilitate implementation of the Agency's Endocrine Disruptor Screening Program (EDSP). The application of these tools will introduce a potentially more efficient approach to identifying potential endocrine disruptors and apply this information across the life cycle of a chemical, for example by using the 2006 Information Update Rule (IUR) and Toxics Release Inventory (TRI). Given the thousands of chemicals in use and the potential risks to human health and the environment, this research is critical to help the Agency meet its priority of strengthening chemicals management and risk assessment.

Continuing from FY 2010 into FY 2011, EPA is launching ExpoCast™. The initiation of the ExpoCast™ program will ensure that the required exposure science and computational tools are ready to address global needs for rapid characterization of exposure potential arising from the manufacture and use of tens of thousands of chemicals. Outcomes of the program also will meet challenges posed by new toxicity testing approaches. The overall goal of this project is to develop novel approaches and tools for screening, evaluating and classifying chemicals, based on the potential for biologically-relevant human exposure, to inform prioritization and toxicity testing. An emphasis will be placed on conducting research to mine and translate scientific advances and tools in a broad range of fields to provide information that can be used to support enhanced exposure assessments for decision making and improved environmental health. ExpoCast™ will provide an overarching framework for the science required to characterize biologically-relevant exposure in support of the Agency computational toxicology program. ExpoCast™ is expected to require several years of investment to be fully operational but, like ToxCast™, it will have interim milestones. By FY 2011, EPA expects to have the first relational databases of exposure studies available through EPA's ACToR system (see description below).

Information Technology

Advanced information management systems are needed to mine existing data for patterns, and to appropriately place new chemicals of unknown hazard within the context of data on existing

[37] Collins et al., 2008, *Science;* http://www.sciencemag.org/cgi/reprint/319/5865/906.pdf

chemicals. These advanced systems allow the integration of data from many different domains of toxicology, and allow for efficient expansion with information on new chemicals and other materials.

EPA has developed several advanced databases and management applications. The Aggregated Computational Toxicology Resource project (ACToR)[38], is a Web-based public resource that currently has information from over 200 sources on over 500 thousand chemicals and other substances. ACToR organizes information from various data generation efforts including:

- EPA's ToxCast™ and ExpoCast™ programs,
- EPA's Toxicology Reference Database (ToxRefDB)[39],
- EPA's Distributed Structure Searchable Toxicity (DSSTox) Database Network[40], and
- The Tox21 high-throughput screening collaboration of EPA and NIH.

The CTRP will significantly expand data generation and management systems throughout the next several years as more data sources (e.g., those covering exposure analyses) and user functionality (e.g., bulk searching) are added in quarterly updates.

Systems Biology Models

Modeling now plays a crucial role in practically all areas of biological research. Systems models integrate information at all levels of organization and aid in bridging the source-to-outcome gap and in conducting quantitative risk assessments. In FY 2011, this research will continue to:

- Provide standards for developing, documenting, archiving, and accessing quantitative mathematical models;
- Utilize systems-modeling approaches for the latest biological, chemical, and exposure data for quantitative risk assessment;
- Develop guidance on best practices for the construction, analysis and reporting of toxicological models that link pharmacokinetic information with the dynamic responses of target organs; and
- Implement the Virtual Liver and Virtual Embryo Projects.

Collectively, these elements will provide a framework that integrates mechanistic information and data for predicting the risk of adverse outcomes in humans through dynamic simulation.

Performance Targets:

Work under this program supports EPA Strategic Objective 4.4: Enhance Science and Research. Specifically, the program identifies and synthesizes the best available scientific information, models, methods, and analyses to support Agency guidance and policy decisions with a focus on human, community, and ecosystem health. Currently, there are no formal external performance measures for this specific program, however, the program has annual research milestones that are included in the multi-year research plans for Human Health and Pesticides and Toxics. The CTRP tracks and manages performance through the timely completion of these milestones.

[38] http://actor.epa.gov/actor/faces/ACToRHome.jsp
[39] http://www.epa.gov/ncct/toxrefdb/
[40] http://www.epa.gov/ncct/dsstox/index.html

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$2,000.0) This reflects an increase for next-generation tools to speed and facilitate implementation of the Agency's Endocrine Disruptor Screening Program (EDSP). The application of these tools will introduce a more efficient approach to identifying potential endocrine disruptors and apply this information across the life cycle of a chemical. This research is critical to help the Agency meet its priority of strengthening chemicals management and risk assessment.

- (+$285.0) This represents a restoration of resources transferred in FY 2010 to the Research: Sustainability program to support Small Business Innovation Research (SBIR). For SBIR EPA is required to set aside 2.5 percent of funding for contracts to small businesses to develop and commercialize new environmental technologies. After the FY 2011 budget is enacted, when the exact amount of the mandated requirement is known, FY 2011 funds will be transferred to the SBIR program.

- (-$28.0) This decrease in travel costs reflects an effort to reduce the Agency's travel footprint by promoting green travel and conferencing.

- (-$473.0) This decrease is the net effect of increases for payroll and cost of living for existing FTE, combined with a reduction based on the recalculation of base workforce costs.

- (+$23.0 \ +1.9 FTE) This increase reflects the net result of realignments of resources such as critical equipment purchases and repairs, travel, contracts, and general expenses to better align with programmatic priorities, including 1.9 FTE with associated payroll of $251.0. Realignments of these resources are based on FTE allocations as well as scientific equipment needs.

Statutory Authority:

TSCA; FIFRA; FQPA; SDWA; ERDA.

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	*$9,948.7*	*$11,355.0*	*$17,378.0*	*$6,023.0*
Total Budget Authority / Obligations	$9,948.7	$11,355.0	$17,378.0	$6,023.0
Total Workyears	50.6	50.1	44.2	-5.9

Program Project Description:

The Endocrine Disruptors Research program provides direct support to EPA's endocrine screening and testing programs (mandated under the Food Quality Protection Act of 1996 and the Safe Drinking Water Act Amendments[41] of 1996) by evaluating current testing protocols and developing new protocols to evaluate potential endocrine effects of environmental agents. The research program also develops and applies methods, models, and measures to evaluate real-world exposures to endocrine disruptors and characterize related effects resulting from these exposures for humans and wildlife. In addition, the program develops risk management tools to prevent or mitigate exposures to endocrine disrupting chemicals (EDCs).

Research assists decision-makers in reducing and preventing exposure of humans and ecosystems to endocrine disruptors. EPA's Endocrine Disruptors Research program contributes to the scientific foundation for the Agency's actions to protect Americans against unreasonable risk from exposure to toxicants that interfere with the endocrine system and supports the Administrator's priorities for assuring the safety of chemicals, protecting America's waters and building strong state and Tribal partnerships. The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering.

Research is guided by the Endocrine Disruptors Research Plan (EDRP) which was developed with participation from major research clients and stakeholders to outline research needs and priorities.[42] The Agency also maintains a multi-year plan (MYP)[43] for Endocrine Disruptors research that outlines steps for meeting these needs, as well as annual performance goals and key research outputs for evaluating progress.

41 SDWA Section 1457.

42 U.S. EPA, Office of Research and Development, *Research Plan for Endocrine Disruptors*. Washington, D.C.: EPA (1998).
Available at: http://www.epa.gov/ord/htm/documents/ORD-EDR-Feb1998.pdf.

43 U.S. EPA, Office of Research and Development, *Multi-Year Plan for Endocrine Disruptors (draft)*. Washington, D.C.: EPA (2007).
Available at: http://www.epa.gov/ord/npd/pdfs/Draft-EDCs-MYP-091407.pdf.

Scientific review of the EDRP is conducted by EPA's Board of Scientific Counselors (BOSC), a Federal advisory committee composed of independent expert scientists and engineers. In April 2008, a BOSC subcommittee evaluated the EDRP and its progress on implementation of the recommendations from previous BOSC program reviews. The subcommittee commended the progress and direction of the research[44] and rated the overall progress of the EDRP program as "*exceeds expectations.*"

The subcommittee noted that "this program has established itself as a leader in several areas of EDCs research. It has leveraged expertise across the Agency and with other Federal and academic scientists; it has been quick to respond and adapt its focus and research questions to the rapidly changing research landscape of EDCs; and it has developed an excellent new MYP. The EDRP has accomplished a remarkable amount in the face of diminishing financial resources." In reviewing EPA's response to the recommendations[45] from the previous BOSC review, the subcommittee acknowledged that the research program "partnered extensively with other agencies with interests in EDCs." The subcommittee remarked that "EPA has been a leader in the development of genomics, proteomics, metabolomics, computational modeling, and whole animal endpoints to identify biomarkers of exposure to EDCs."

FY 2011 Activities and Performance Plan:

In FY 2011, resources will continue to be used to develop, evaluate, and apply innovative DNA microarray and other state-of-the-art analytical methods for endocrine disrupting chemicals. EPA has developed and refined assays and improved other screening tools using new molecular capabilities so that the Agency has the necessary protocols for use in the Endocrine Disruptors Screening program. Using genomics and related approaches to develop improved molecular and computational tools can help prioritize chemicals for screening and testing that will lead to a reduction of animal testing. This work has been highlighted as a priority for cross-government investment. It is also consistent with the National Research Council's 2007 report on "Toxicity Testing in the Twenty-first Century: A Vision and a Strategy," which recommends that the Agency move toward using new technologies to prioritize and screen for chemicals.[46]

In FY 2011, the research program will continue:

- Finalizing Tier 2 testing assays – a high priority for the Agency in implementing the Endocrine Disruptor Screening Program (EDSP);
- Developing the next generation of EDSP assays by applying newer computational and molecular approaches to develop models that predict a chemical's ability to cause endocrine disruption;
- Determining classes and potencies of chemicals that act as endocrine disruptors, characterizing modes of action and the shape of the dose-response curve, developing

44 U.S. EPA. Office of Research and Development. EDC Research Program Review. Washington, D.C. (2008)
Available at: http://www.epa.gov/osp/bosc/pdf/edcmc0804rpt.pdf.

45 U.S. EPA, Office of Research and Development, EDC Research Program Review. Washington, D.C. (2005).
Available at: http://www.epa.gov/osp/bosc/pdf/edc0504rpt.pdf.

46 National Academies Press (2007). Available at: http://www.nap.edu/catalog.php?record_id=11970#toc.

approaches for assessing cumulative risk, and developing methods for extrapolating results across species, which would lead to reduced animal testing;

- Developing molecular indicators of exposure and analytical methods for detecting certain EDCs, identifying the key factors that influence human exposures to EDCs; and identifying sources of EDCs entering the environment, focusing on wastewater treatment plants, concentrated animal feeding operations (CAFOs) and drinking water treatment plants; developing tools for risk reduction and mitigation strategies; and
- Applying its multidisciplinary expertise to better characterize the impact on environmental media and aquatic organisms of real world releases of endocrine active compounds (including natural hormones, pesticides, industrial chemicals, and pharmaceuticals) from wastewater treatment plants, CAFOs, and drinking water plants and developing risk management and mitigation strategies.

The FY 2011 request includes significant additional funding to award research grants to academia under the Science to Achieve Results (STAR) grant program, complementing the Agency's intramural research effort on EDCs. The additional resources will allow for an acceleration in the application of the latest state of the art technologies and innovations to advance the assessment and management of environmental endocrine disruptors and other emerging contaminants of concern, in order to better ensure rapid, agile, and accurate protection of human health and wildlife. EPA anticipates that these activities will directly benefit the Endocrine Disruptor Screening Program (EDSP) in the Office of Prevention, Pesticides and Toxic Substances.

Researchers in the Endocrine Disruptors, the Pesticides and Toxics, and Human Health research programs will work together on integrated, goal oriented issues, and will plan and execute work to develop high capacity decision support tools for managing contaminants across their life-cycles. This research will build upon and expand the activities conducted within the Computational Toxicology Program and its partnerships with the National Institute of Environmental Health Sciences and the NIH Chemical Genomics Center. The program will provide partners, such as EPA's Program and Regional Offices, other federal agencies, international agencies, and the general scientific community, with a more efficient means of assessing exposure and hazards of chemicals. Partners will be able to efficiently evaluate the impact of large numbers of chemicals in everyday commerce on human health (individual and susceptible populations) facilitating prioritization for further chemical research, management, and product design decisions. The program has worked to articulate its research and development priorities to ensure compelling, merit-based justifications for funding allocations in response to assessments of its purpose, performance planning and management.

Performance Targets:

The research conducted under this program supports EPA Strategic Objective 4.4. Specifically, the program identifies and synthesizes the best available scientific information, models, methods, and analyses to support Agency guidance and policy decisions related to the health of people, community, and ecosystems, with a focus on endocrine-active pesticides and toxic chemicals.

Currently, there are no annual performance measures for this program project. The program's long-term performance measures are: (1) to provide improved screening and testing protocols for

use in implementing the Agency's Endocrine Disruptors Screening program; (2) to determine the extent of the impact of endocrine disruptors on humans, wildlife, and the environment to better inform the Federal and scientific communities; and (3) to reduce the uncertainty regarding the effects, exposure, assessment, and management of endocrine disruptors so that EPA has a sound scientific foundation for environmental decision-making. The research program also has developed performance indicators that monitor research activities and outputs. Targets for these include screening and testing protocols that EPA's Prevention, Pesticides and Toxic Substances program will validate for use in evaluating the potential for chemicals to cause endocrine-mediated effects.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$7,000.0) This increase funds additional Science to Achieve Results (STAR) Grants. Additional research funding will award grants to academia through ORD's STAR program, complementing the Agency's intramural research effort on endocrine disrupting chemicals (EDCs). This will allow for an acceleration of applying the latest state of the art technologies and innovations to advance the assessment and management of environmental endocrine disruptors and other emerging contaminants of concern.

- (+$37.0) This represents a restoration of resources transferred in FY 2010 to the Research: Sustainability program to support Small Business Innovation Research (SBIR). For that program, EPA is required to set aside 2.5 percent of funding for contracts to small businesses to develop and commercialize new environmental technologies. After the FY 2011 budget is enacted, and the exact amount of the mandated requirement is known, FY 2011 funds will be transferred to the SBIR program.

- (-$43.0) This decrease in travel costs reflects an effort to reduce the Agency's travel footprint by promoting green travel and conferencing.

- (-$770.0 \ -4.3 FTE) This reflects the net result of realignments of FTE and resources such as critical equipment purchases and repairs, travel, contracts, and general expenses to better align with programmatic priorities, and includes a reduction of 4.3 FTE with decreased associated payroll of $576.0. Realignments are based on FTE allocations as well as scientific equipment needs.

- (-$415.0 \ -1.6 FTE) This represents a net realignment of FTE and resources for research to address exposure issues related to potential chemical and/or pesticide stressors to better reflect program support needs, and includes a reduction of 1.6 FTE with decreased associated payroll of $214.0. This change reflects EPA's workforce management strategy that will help the agency better align resources, skills and Agency priorities.

- (+$214.0) This decrease is the net effect of increases for payroll and cost of living for existing FTE, combined with a reduction based on the recalculation of base workforce costs.

Statutory Authority:

CAA; ERDDA; FIFRA; TSCA; FQPA; SDWA; CWA; RCRA; CERCLA; PPA.

Research: Global Change
Program Area: Research: Clean Air
Goal: Healthy Communities and Ecosystems
Objective(s): Enhance Science and Research

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	*$17,264.1*	*$20,826.0*	*$21,985.0*	*$1,159.0*
Total Budget Authority / Obligations	$17,264.1	$20,826.0	$21,985.0	$1,159.0
Total Workyears	36.9	35.5	40.1	4.6

Program Project Description:

EPA's Global Change research program is focused on understanding and assessing the effects of global change—particularly climate variability and change—on air quality, water quality, aquatic ecosystems, human health and social well being in the United States and supports the Administrator's priorities for taking action on climate change, improving air quality and protecting America's waters. The Agency strives to produce timely and useful information, decision support tools and adaptation strategies that will enable resource managers, policymakers, and other stakeholders to account for global change when making decisions. EPA also is developing decision support tools to help decision makers evaluate alternative strategies for reducing greenhouse gas emissions to better quantify the environmental implications (and potential co-benefits) associated with deployment of these strategies. The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering.

The program partners with program and Regional Offices to understand how climate change affects the Agency's ability to fulfill its statutory, regulatory, and programmatic requirements, and identifies opportunities within the provisions of the statutes (e.g., the Clean Air Act, Clean Water Act, and Safe Drinking Water Act) to address the anticipated impacts of a changing climate. Interactions between climate and air quality and climate and water quality are likely to play larger roles in ambient air and water health assessments in the future. To meet this challenge, the Clean Air Research program, the Drinking Water Research program, and the Water Quality Research program, are all working closely with the Global program to develop frameworks for the research that will be most useful to stakeholders charged with protecting public and environmental health.

The program is an active participant in the U.S. Global Change Research Program (USGCRP), the interagency Federal effort to improve scientific understanding of climate change and global change.[12] EPA's program priorities are consistent with those of the USGCRP, which coordinates and integrates climate change and global change research among thirteen Federal departments

12 For more information, see http://www.globalchange.gov/.

and agencies, and USGCRP's Strategic Plan[13]. The program also is guided by a multi-year research plan developed by EPA, which is currently under revision.

A subcommittee of EPA's Board of Scientific Counselors (BOSC)—a Federal advisory committee composed of qualified, independent scientists and engineers—conducted a peer review of the program in 2005, and reported that the program "has provided substantial benefits to the nation and that it is on course to make significant further contributions."[14] The subcommittee completed a mid-cycle review of the program in 2008 and reaffirmed its assessment of the program.

FY 2011 Activities and Performance Plan:

In FY 2011, EPA research will continue to focus on four areas:

- Understanding how climate change will affect air quality in the United States;
- Understanding how climate change will affect water quality and aquatic ecosystems;
- Evaluating alternative strategies for reducing greenhouse gas emissions and the environmental implications of those strategies; and
- Supporting the statutory mandates of the USGCRP to produce periodic assessments of the effects of climate change.

Research and assessments, in all four areas, will continue to improve understanding of the implications of climate change for human health. They also will address the impacts of alternative adaptation and mitigation strategies.

The Global Change research program will continue to provide support to decision makers with areas of responsibility likely to be affected by climate change, such as air quality district managers, state environmental agencies, watershed managers, and operators of waste and drinking water systems. FY 2011 funding will continue research to develop, in collaboration with EPA's Water program, detailed watershed-based, stakeholder-driven studies focused on local issues and specific management solutions for addressing global change, and assess, in collaboration with EPA's Air and Radiation program, the linkages between global climate change, regional air quality and health effects. This research will be the basis for key comprehensive assessments of how climate change will affect U.S. air and water quality and particular areas of vulnerability. These assessments will help EPA's Air and Water programs understand how climate change will affect their ability to meet statutory, regulatory, and programmatic requirements and account for climate change's effects in their future actions.

13 National Science and Technology Council, *Strategic Plan for the U.S. Climate Change Science Program* (Washington: NSTC, 2003). Available at: http://climatescience.gov/Library/stratplan2003/

14 U.S. EPA, Board of Scientific Counselors, Subcommittee on Global Change Research, *Review of the Office of Research and Development's Global Change Research Program at the U.S. Environmental Protection Agency, Final Report.* Washington, D.C.: EPA (2006), 6. See http://www.epa.gov/osp/bosc/pdf/glob0603rpt.pdf.

The National Research Council (NRC) of the National Academies recently highlighted the importance of the EPA's decision support activities in its 2009 report, *Informing Decisions in a Changing Climate*[15] and recommended that EPA "expand its climate-related decision support programs to serve more regional and sectoral constituencies." As recommended by the NRC, the program began to place greater emphasis on its decision support efforts in FY 2009. These efforts include inventorying and assessing the climate-sensitive decisions made by local and state decision makers to identify which decisions are most impacted by climate change and which decisions can benefit most from EPA's scientific findings. In FY 2009, EPA supported the stakeholder-oriented process by the Alaska Department of Environmental Conservation to develop a Climate Change Strategy. EPA will continue to assist the State of Alaska as it implements its adaptation strategy and expects that this will serve as a model for future state strategies. This research responds to the BOSC recommendation that the program develop a new strategy for place-based adaptation decision support activities that recognizes the importance of engaging local stakeholders while ensuring that the results of the investment have extended applicability of national significance.

In FY 2011, the program will continue to develop computer models that simulate how global change may affect U.S. air quality,[16] continuing progress toward the program goal to complete a framework linking global change to air quality. The program also will model and evaluate potential adaptive responses to climate change, such as changes in energy, pollution control, and transportation technologies, and behavior in various regions and sectors of the U.S.[17] Program efforts will help air quality resource managers make informed decisions about how to respond to the effects of global change on air quality. They are also a critical component of the Assessment of the Implications of Global Change for Air Quality in the U.S, planned for release in 2012.

In FY 2009, the program began a comprehensive assessment of the effects of climate change on water quality, including aquatic ecosystems. In FY 2011, EPA will continue research on the effects of global change, including changes in land use and climate change, on water systems. This information will assist in determining climate change impacts on water resources in different regions and in the development of decision support tools needed to protect water quality and aquatic ecosystems.

In FY 2011, the program also will continue to perform research, in collaboration with other programs, to provide information that will inform efforts to mitigate greenhouse gases and other radiative forcing compounds. The program will provide technical information on the environmental and human health implications of alternative technologies to EPA program offices responsible for developing and implementing regulations and legislation to reduce greenhouse gas (GHG) emissions. The research also will identify potential mitigation options that could reduce both traditional air pollutants (e.g., ozone and particulate matter) and greenhouse gases. Research on geologic sequestration of carbon dioxide and the impacts of different capture technologies, in partnership with EPA's Drinking Water research program and the Department of Energy, will support the Water program's carbon sequestration rulemaking.

15 For more information, see http://www.nap.edu/catalog.php?record_id=12626

16 For more information, see http://www.epa.gov/nerl/goals/global/.

17 For more information, see http://www.epa.gov/appcdwww/apb/greengas.htm.

The U.S. Global Change Research Act of 1990 mandates periodic scientific assessments of the effects of global change.[18] Section 106 of the act states that these assessments should integrate and interpret the findings of the Federal government's climate change research; analyze the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; analyze current trends in global change; and project major trends for the next 25 to 100 years. EPA, beginning in FY 2006, has participated in the development of CCSP's Synthesis and Assessments Products (SAPs), serving as lead agency for three of the 21 assessments.[19] Two EPA SAPs, Adaptation Options for Climate-Sensitive Ecosystems and Resources (SAP 4.4) and Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems (SAP 4.6), were released in calendar year 2008. The third SAP (SAP 4.1), Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region, was released in January 2009. EPA will continue to participate in USGCRP's programmatic, assessment, and planning activities.

The global change research program makes extensive use of the Science to Achieve Results (STAR) program's competitive, peer-reviewed grants. In FY 2011, STAR's global change component will focus on two research areas. First, new grants will fund development of effective strategies to both mitigate climate change and reduce air pollution while accounting for future changes in climate, land use, and technology. One component of these grants will jointly consider the climate and air quality impacts of strategies to reduce black carbon. Second, STAR funding will enable investigation of the sensitivity of U.S. water systems to global change. Research in this area will improve our understanding of opportunities and the effectiveness of adaptive responses to reduce the risk of impaired water quality and ecosystem services at the watershed scale. Research also will address the potential adaptive benefits of low impact neighborhood design, green infrastructure, soil and water conservation practices, and other potential responses to reduce the risk of future aquatic ecosystem and water quality impacts.

To improve the Research: Global Change program, EPA has taken steps to finalize independent, review-informed performance measures; clarify the program's framework and mission; develop a means to measure the program's efficiency; and improve budget–performance integration. The program is finalizing long-term performance targets and will collect formal long term measurement data during its comprehensive BOSC review scheduled for early 2010. Additionally, the program is revising and broadening its multi-year plan around a clearer framework, and has developed an approach for improving program efficiency.

Performance Targets:

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered.	100	100	100	100	Percent

18 See 15 USC §2936.

19 For more information, see http://www.climatescience.gov/Library/sap/sap-summary.php.

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of Global publications rated as highly cited publications.	23	Data Avail 2010	No Target Established	24	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of Global publications in high impact journals.	24.6	Data Avail 2010	No Target Established	25.6	Percent

The research conducted under this program supports EPA Objective 4.4. Specifically, the program identifies and synthesizes the best available scientific information, models, methods, and analyses to support Agency guidance and policy decisions related to the health of people, community, and ecosystems, with a focus on global change.

The program gauges its annual and long term success in meeting this objective by assessing its progress on several key measures. Improvements in these measures demonstrate increased quality and utility of the program's research. In addition, the program plans to meet 100 percent of its planned outputs, and complete additional work toward a framework linking global change to air quality. By meeting these targets, the research program will improve the Agency's ability to make guidance and policy decisions related to global change.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$3.0) This reflects an increase for payroll and cost of living for existing FTE.
- (+$427.0 \ +3.0 FTE) This represents a realignment of resources from the Air program to the Global Change program for research on air quality-climate interactions and feedback to effectively couple regional air quality and global climate models and includes 3.0 FTE with associated payroll of $431.0.
- (+$232.0) This represents a restoration of resources transferred in FY 2010 to the Research: Sustainability Program/Project to support Small Business Innovation Research (SBIR). For that program, EPA is required to set aside 2.5 percent of funding for contracts to small businesses to develop and commercialize new environmental technologies. After the FY 2011 budget is enacted, when the exact amount of the mandated requirement is known, FY 2011 funds will be transferred to the SBIR program.
- (+$233.0 \ +1.6 FTE) This reflects the net result of realignments of FTE and resources such as critical equipment purchases and repairs, travel, contracts, and general expenses to better align with programmatic priorities, and includes 1.6 FTE with associated payroll of $230.0. These realignments are based on FTE allocations as well as scientific equipment needs. This change reflects EPA's workforce management strategy that will help the Agency better align resources, skills and Agency priorities. This increase is the net result of realignments of support FTE to better align with programmatic priorities.

- (-$26.0) This decrease in travel costs reflects an effort to reduce the Agency's travel footprint by promoting green travel and conferencing.

Statutory Authority:

USGCRA; NCPA; ERDDA.

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	*$155,752.0*	*$159,511.0*	*$154,093.0*	*($5,418.0)*
Total Budget Authority / Obligations	$155,752.0	$159,511.0	$154,093.0	($5,418.0)
Total Workyears	492.5	484.9	475.3	-9.6

Program Project Description:

EPA's health and ecological research programs provide the scientific foundation for the Agency's actions to protect Americans' public health and environment and supports the Administrator's priorities for improving air quality, assuring the safety of chemicals and protecting America's waters. The Agency conducts integrated research on human health and ecosystems to identify and characterize environment-related human health problems, determine exposures to and sources of agents responsible for these health concerns, use public health indicators to evaluate the effectiveness of risk management decisions, quantify the impacts of human activities on the benefits and services provided by ecosystems, measure the relationship between human well being and ecosystem services, and provide tools for policy makers and managers to protect and restore ecosystem services through informed decision making at multiple spatial and temporal scales.

The program also supports mercury research, advanced monitoring research, nanotechnology research, exploratory research, and the Agency's Report on the Environment (ROE). The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering.

The Human Health Research Program (HHRP) continues to characterize and reduce uncertainties in risk assessment within the framework of "developing and linking indicators of risk" along the potential source-to-exposure-to-effects-to-disease continuum. The program is evolving from a single chemical approach to one that addresses the cumulative risk of multiple chemicals in the context of community settings. Advanced exposure models and information about key molecular events in toxicity pathways are being used to illuminate potential risks of environmental contaminants in real world settings where chemical and non-chemical stressors interact to impact human health. Tools and indicators are being developed and verified to help decision makers measure and demonstrate reductions in environmental-related human disease incidence or severity that results from their risk management actions. The program addresses limitations, gaps, and challenges articulated in EPA's *Report on the Environment* (2008) and is responding to recommendations in the National Research Council's reports "*Toxicity Testing in the 21st Century: A Vision and a Strategy*" (2007) and "*Science and Decisions: Advancing Risk Assessment*" (2009).

In FY 2009, the Ecosystem Services research program (ESRP) fully transitioned to its new focus on conserving and protecting ecosystem services through proactive decision making[52]. This focus synthesizes and builds upon the program's previous accomplishments in quantifying the ecological condition of the nation's aquatic resources, as well as in developing ecological stressor-response models, methods to forecast alternative future scenarios, and methods to restore ecological functions and ecosystem services within degraded systems. By integrating these tools within a common framework to assess ecosystem services, the program can better investigate and advance opportunities for more quickly achieving desired environmental outcomes at lower cost and with fewer unintended consequences.

Research is guided by the "Human Health Research Strategy"[53] and the "Ecological Research Strategy,"[54] which were developed in collaboration with major clients and stakeholders (e.g., EPA's program and Regional Offices). These strategies outline research needs and priorities. In addition, multi-year plans (MYPs)[55] (e.g., human health, ecological research, and mercury) convey research priorities and approaches for achieving the goals and objectives of protecting communities. MYPs outline the steps for meeting client research needs, as well as annual performance goals and key research outputs for evaluating progress.

In December 2009, an evaluation by EPA's Board of Scientific Counselors (BOSC)—a Federal advisory committee composed of independent expert scientists and engineers—concluded that the HHRP exceeds expectations in the area of developing tools to evaluate risk, while meeting expectations in all other areas. The BOSC report[56] noted that HHRP is much more integrated since the previous review. Also, there is considerably more emphasis on human health and human health-related issues, as well as movement toward more of a public health-themed program. The BOSC also stated that "[t]he HHRP, as a whole, appears to be robust and responsive to emerging issues," and that "[t]here appears to be good evidence for strong scientific productivity and a formidable impact of the work produced by the program overall."

The ESRP has been recognized as holding a unique position within the Federal government for its research to establish and communicate a greater understanding of the value of ecosystem services and their interdependent relationship to human activities and well being[57]. In 2007, the mid-cycle BOSC review of the ESRP resulted in a rating of "Meets Expectations" for work completed to date.[58] A full program review by the BOSC will take place in FY 2011.

In 2008, EPA's Science Advisory Board's (SAB) Ecological Processes and Effects Committee (EPEC) stated in its review of the program that:

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[52] The ESRP name came from a recommendation by the SAB Ecological Processes and Effects Committee to adopt a name that better reflects the program's role as the Agency's first integrated research program to address the difficult topic of maintaining, enhancing, and restoring the services provided by the natural environment.

[53] U.S. EPA, Office of Research and Development. *Human Health Research Strategy*. Washington, DC: EPA. Available at: http://www.epa.gov/nheerl/humanhealth/HHRS_final_web.pdf

[54] For more information, see http://www.epa.gov/ord/htm/documents/eco.pdf.

[55] For more information, see http://www.epa.gov/ord/htm/multi-yearplans.htm.

[56] U.S. EPA, Board of Scientific Counselors. Review of the Office of Research and Development's Human Health Research Program at the U.S. Environmental Protection Agency. (Washington: EPA, 2009). Available at: http://www.epa.gov/osp/bosc/pdf/hh0912rpt.pdf.

[57] BOSC 2007 http://www.epa.gov/osp/bosc/.

[58] U.S. EPA, Board of Scientific Counselors. Mid-Cycle Review of the Office of Research and Development's Human Health Research at the U.S. Environmental Protection Agency. (Washington: EPA, 2007). Available at: http://epa.gov/osp/bosc/.

> "The draft Plan articulates a new strategic direction that focuses on quantifying ecosystem services and their contribution to human health and well-being. The SAB strongly supports this strategic direction and commends the Agency for developing a research program that, if properly funded and executed, has the potential to be transformative for environmental decision making as well as for ecological science. The SAB finds that the research focus on ecosystem services represents a suitable approach to integrate ecological processes and human welfare. The ESRP's focus on ecosystem services can provide a sound foundation for environmental decisions and regulation based on the dependence of humans on ecological conditions and processes."[59]

The program was again reviewed in July 2009, and the final report[60] was released in September. The SAB found that the ESRP is "bold, innovative, and necessary", and "because it is taking an integrated multidisciplinary approach to addressing multiple stressors acting within and across media, the research program has the potential, with appropriate support, to transform the way environmental decisions are made within and outside of EPA."

EPA and its external reviewers, including the EPA Science Advisory Board and National Science Foundation, have recognized that a statute-specific research approach is limited in its potential for solving modern environmental problems. While the Human Health and the Pesticides and Toxics research programs have made many important contributions to EPA decision making and have worked to integrate various disciplines throughout the programs, they could benefit by building upon important synergies and emerging tools to address these evolving environmental problems. Therefore, moving in that direction, portions of the Human Health research program are being aligned with related aspects of the Pesticides and Toxics research program. The result will be a more holistic research program that maximizes responsiveness to the rapidly changing needs of EPA's program and Regional Offices and other critical partners.

FY 2011 Activities and Performance Plan:

Human Health Research

In FY 2011, EPA's research under this program will continue to identify indicators of exposure, effects, and susceptibility that the Agency needs to evaluate and manage health risks of chemical contaminants for individuals, communities and populations while considering susceptibility at all stages of the human life cycle. Increased emphasis is being placed on refining advanced modeling tools to estimate human exposures and using 21st Century molecular and cellular tools to identify key steps in chemically-induced toxicity. These tools will be applied in community settings to manage risks of complex exposures and factor in non-chemical stressors that interact with chemical stressors to impact health. Furthermore, research will identify and validate public health indicators needed to demonstrate the benefits of regulatory decisions and actions and to identify communities at highest risk. Of the total $154.1 million requested in FY 2011 for Human Health and Ecosystems research, $80.1 million is requested for research in this area.

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[59] EPA-SAB-08-011

[60] http://yosemite.epa.gov/sab/sabproduct.nsf/WebReportsLastFiveBOARD/91190EEC56A44B3F85257641006BB7D7/$File/EPA-SAB-09-019-unsigned.pdf

EPA will continue to support research on modes of action of priority chemicals and build models for cumulative risk assessments with the ultimate goal of basing regulatory decisions and rules on sound science rather than relying on default assumptions. Such research will inform EPA's evaluations of acceptable levels of arsenic and its metabolites in drinking water and the cancer and non-cancer effects of conazoles and structurally related fungicides. In addition, mode of action, exposure, and dose modeling research on pyrethroid pesticides and disinfection byproducts will inform upcoming cumulative risk assessments by the Prevention, Pesticides, and Toxic Substances program and the Water program in EPA. New research efforts guided by the National Research Council's report, "Toxicity Testing in the 21st Century: A Vision and a Strategy" (2007), will apply molecular and genomic information to identify key events in specific toxicity pathways and to develop virtual organ models of predictive toxicity in collaboration with the Computational Toxicology research program.

In addition, FY 2011 research will focus on developing tools for identifying communities (e.g. localities, populations, groups) at disproportionate risk from exposure to multiple chemicals, identifying and quantifying the factors influencing these exposures, and developing and implementing appropriate risk reduction strategies. Cumulative risk research will develop and refine models for analyzing complex exposures and for predicting exposures. For example, the Stochastic Human Exposure and Dose Simulation (SHEDS) multimedia model is EPA's state-of-the-science probabilistic model for simulating pesticides, metals, and persistent bioaccumulative toxins. At the community level, tools are being developed for linking various exposure databases for use by communities and EPA's regional offices in characterizing risks. Research will also develop methods for reconstructing exposures based upon biomarker and biomonitoring data generated in large scale exposure and epidemiological studies. This research will enable EPA to link such exposures to their primary sources, and facilitate use of exposure, biomarker, and pharmacokinetic data in cumulative risk assessments. It will also help EPA to address recent GAO recommendations in its report, *Biomonitoring. EPA needs to coordinate its research strategy and clarify its authority to obtain biomonitoring data* (GAO 09-353). New efforts will begin to identify non-chemical stressors in community settings and define the extent to which they may modify an individual's response to a chemical stressor, possibly resulting in disproportionate risk.

A major focus of HHRP is directed at protecting vulnerable populations and life stages, particularly children. In 2011, EPA will continue to co-fund the Children's Environmental Health and Disease Prevention Centers (Children's Centers) with NIEHS. These unique Children's Centers perform targeted research in children's environmental health and translate their scientific findings into intervention and prevention strategies by working with communities. The Children's Centers have established long term birth and school age cohorts that follow participants over multiple years to consider the full range of health effects resulting from exposure to environmental chemicals, as summarized in the EPA report "A Decade of Children's Environmental Health" (2007).

Additionally, HHRP research will examine the factors that impact children's exposures in specific environments encountered by very young children and by school aged children. Research will focus on the impact and relationship between environmental factors and sustainable building practices. The information obtained will help school systems verify and

implement best practices to optimize healthy learning environments. An early product will be new information about sources of persistent bioaccumulative toxins in schools related to its previous use in caulking, and possible engineering solutions for reducing exposures to children and teachers. Research also will provide fundamental information about the inherent biological, developmental and genetic factors that determine children's susceptibility to chemically-induced insults, including the potential of very early exposure (e.g. during pregnancy and infancy) to contribute to the development of chronic diseases later in life such as asthma, hypertension, and obesity. The Agency needs this information to ensure adequate protection of children and other vulnerable groups in all its regulatory actions. Emerging risks of long term health effects such as obesity and hypertension resulting from early life exposures are being examined in laboratory animal models and children's cohort studies. Information gained from this research and from the Children's Centers is informing the conduct of the National Children's Study (NCS), a longitudinal study funded by the National Institute of Health (NIH). EPA is an active partner in this interagency study, and will continue to provide advice and expertise to NCS, including collaborative research to help optimize methods and interpret results.

In FY 2011, research on public health outcomes will continue to assess the cumulative impact of a suite of air pollution reduction programs on environmental public health indicators, especially those relevant to children and older populations. Research results on new tools to measure the effectiveness of regulatory decisions, such as upgrades to water treatment facilities based on the incidence of infectious disease from waterborne pathogens, will be reported. In response to gaps identified in EPA's Report on the Environment (2008), EPA will move toward integrating a range of valid and predictive bioindicators of exposure, susceptibility and effects to develop approaches to assess public health impacts of regulatory decisions. These efforts include developing and validating novel environmental health outcome indicators in community settings through the Science to Achieve Results (STAR) grant program. This research, which assists EPA in evaluating the impact of its risk management decisions, received a rating of "Exceeds Expectations" from the 2009 Human Health BOSC subcommittee review.

EPA's Human Health Research program is greatly enhanced by the STAR program's competitive, peer-reviewed grants. The STAR program has funded and will continue to fund an array of outstanding grants that fill unique needs for community-based participatory research on environmental public health outcomes of great concern, especially for vulnerable populations like children and Tribal communities. For example, the program will continue to fund research to develop and validate predictive bioindicators of exposure and effects that are needed to develop approaches to assess public health impacts of regulatory decisions, including developing environmental health outcome indicators. Given the heightened interest in documenting the benefits of sustainable building practices, the program also will create opportunities to examine the impact of school facility features, building maintenance and operation practices on the health and performance of students and teachers.

Researchers in the Human Health and Pesticides and Toxics research programs will work together on integrated, goal oriented issues, and will plan and execute work to develop high capacity decision support tools for managing contaminants across their life-cycles. EPA will provide decision makers and partners with a more efficient means of assessing exposure and hazards of chemicals. Partners will be able to efficiently evaluate the impact of large numbers of

chemicals in everyday commerce on human health (individual and susceptible populations) facilitating prioritization for further chemical research, management, and product design decisions.

A 2009 performance review of the "Human Health Research" program found that it has "matured" since the 2005 review to become better integrated and that the "scientific content is excellent." The BOSC subcommittee, in its December 2009 report, commended the scientific leadership "for their attempts to enhance the coordination and communication efforts with program offices and through interagency collaborations." The BOSC also commended "the utilization of the combined strengths on both the intramural and extramural fronts" and noted that "the HHRP is well organized and clearly defines its priorities and outcomes." Overall, the BOSC indicated that the program responds to changing priorities and areas of need and has demonstrated "significant progress" and "managed resources efficiently for achieving its [long term goals]." The BOSC's evaluation and recommendations are being used to help plan, implement, and strengthen the program over the next five years.

Researchers in the Human Health and Pesticides and Toxics research programs will work together on integrated, goal oriented issues, and will plan and execute work to develop high capacity decision support tools for managing contaminants across their life-cycles. EPA will provide decision makers and partners with a more efficient means of assessing exposure and hazards of chemicals. Partners will be able to efficiently evaluate the impact of large numbers of chemicals in everyday commerce on human health (individual and susceptible populations) facilitating prioritization for further chemical research, management, and product design decisions.

Ecosystem Services Research

In FY 2011, the total level of funding requested for Ecosystems research is $74.0 million. The Ecosystems Services Research Program (ESRP) responds directly to numerous scientific and policy reports over the last decade that document the need to conserve irreplaceable services provided by ecosystems (e.g., NAS, 1997[61]; MA, 2005[62]; BOSC, 2005[63]; EPA Stewardship Initiative, 2006[64]; EBASP, 2006[65]; Restoring Nature's Capital, 2007[66]). The Millennium Assessment (MA) is one of the most comprehensive reports to date, and documented declines in 15 of 24 ecosystem services worldwide.

The Ecosystem Services Research program is aimed at transforming the way decision makers understand how their environmental management decisions affect the type, quantity, magnitude and sustainability of the goods and services nature provides us. The research complements

[61] "NAS 1997" = Building a Foundation for Sound Environmental Decisions, Chapter 4: EPA's Position in the Broader Research Enterprise, National Academy of Sciences, 1997, available at http://www.nap.edu/openbook/0309057957/html/49.html

[62] http://www.millenniumassessment.org

[63] BOSC 2005 http://www.epa.gov/osp/bosc/pdf/eco0508rpt.pdf

[64] www.epa.gov/epainnov/pdf/rpt2admin.pdf

[65] US EPA. 2006. Ecological Benefits Assessment Strategic Plan. EPA-240-R-06-001. U.S. Environmental Protection Agency, Office of the Administrator, Washington, DC.

[66] Restoring Nature's Capital: An Action Agenda to Sustain Ecosystem Services, 2007," available at http://pdf.wri.org/restoring_natures_capital.pdf.

EPA's regulatory efforts by providing for a systems approach that will enable routine investments from the private and public sectors to create new financial, social, and natural capital (i.e., enhanced ecosystem services). For example, in FY 2010, the ESRP is conducting a scoping study to assess the extent to which ecosystem service markets and incentives could make a cost-effective contribution to the restoration of the Chesapeake Bay. The focus of this new regional study will be to demonstrate how the concept of ecosystem services can be used to achieve reductions in nutrients beyond today's regulatory framework, using existing information and knowledge of ecosystem services. In addition to a demonstration of the concept, the study will include developing guidelines to provide ways to systematically assess economic, financial, and environmental effects of decisions; compare environmental and social trade-offs. This project builds on the results of other ESRP regional projects in the Upper Midwest, coastal Carolinas, Tampa Bay, western Oregon, and the arid Southwest, and on national efforts focusing on nitrogen and wetlands. This work will complement and substitute for more costly infrastructure approaches to nutrient load reduction such as publicly owned treatment works, upgrades and storm water management systems.

Businesses, municipalities, landowners, and states will realize multiple environmental and financial benefits, including diversified revenue streams, by strategically modifying existing expenditures for environmental management, and creating opportunities to develop appropriately designed new markets for ecosystem services. This approach builds upon the Agency's historic emphasis on minimizing the impacts of pollutants (i.e., negative externalities); it creates new ways to enhance the services we receive from functioning ecosystems, in ways that create new economic wealth and better address social equity (i.e., positive externalities). One of the goals of this new balanced approach is to "create demand" for ecological integrity by rewarding stewardship and by connecting with the public on issues of social well being and equity.

In FY 2011, the ESRP will provide research critical to improving the policy and management decisions that affect the type, amount, quality and sustainability of benefits and services provided by ecosystems. The systems-based approach will create ways to examine how a suite of ecosystem services responds to multiple stressors, using both prospective scenario analyses as well as monitoring frameworks to empirically assess changes in ecosystem services over time.

The ultimate goal for the ESRP is that decision makers routinely use information and methods developed by this program to make proactive policy and management decisions that protect the environment and human well being by conserving and enhancing ecosystem services at local, regional, and national scales. To accomplish this, the ESRP will conduct research using several complementary research themes:

- Defining ecosystem services and their implications for human well being and economic valuation;
- Measuring, monitoring, and mapping ecosystem services at multiple scales over time;
- Developing predictive models for quantifying and forecasting the changes in ecosystem services under alternative management scenarios; and
- Developing decision support tools that enable decision makers to integrate, visualize, and maximize diverse data, so they can anticipate and understand the likely consequences of management decisions on the sustainability of ecosystem services, their economic and non-monetary value, and their role in maintaining human well being.

In addition, in FY 2011 the ESRP will examine ecosystem services from three distinct perspectives:

- *Pollutant-based:* examining the effects of pollutants on ecosystem services; in this case, reactive nitrogen, which has implications for several nationally important issues, including upcoming rules for air emissions of NOx/Sox, and NAAQS; hypoxia in the Gulf of Mexico; contribution to greenhouse gases; and management of non-point pollution sources from agricultural and other lands.
- *Ecosystem-based:* examining how stressors affect the suite of ecosystem services derived from wetlands and coral reefs, two important ecosystems for which the Agency has regulatory responsibilities.
- *Regional* assessments at six locations: the Willamette River Basin, OR; Tampa Bay, FL; the Coastal Carolinas; the upper Midwest U.S., an arid-land area in the Southwest U.S., and the Chesapeake Bay. These regional studies are done in collaboration with stakeholders and illustrate how local, state, and regional decision makers can use alternative future scenarios to proactively conserve and enhance ecosystem services. These study locations represent a spectrum of physiographic and socioeconomic characteristics with a variety of drivers of ecosystem change operating at local, regional, and national scales, as well as different types and magnitudes of potential impacts resulting from resource management decisions.

There will be greatly expanded opportunities in FY 2011 to collaborate with non-traditional partners within and outside of EPA because the ESRP incorporates both natural and social sciences. The ESRP has already spurred significant advances in creating a unique, cross-disciplinary, broadly applicable research program. In collaboration with Agency partners, the ESRP has identified five immediate uses for information on ecosystem services:

- Provide technical support for agency policies, including voluntary measures such as environmental stewardship;
- Provide improved techniques for estimating the benefits and costs related to national rulemaking;
- Develop metrics on ecosystem services (e.g., for use in the Report on the Environment);
- Create credible scientific foundations for market incentives (e.g., for ecosystem services trading or for investments in conservation); and
- Identify the "art of the possible;" that is, to explore how policy makers and managers can use this information to simultaneously address multiple environmental issues, identify trade-offs, and reduce conflict in strategies to achieve desired environmental outcomes.

The ESRP research also supports the *EPA Ecological Benefits Assessment Strategic Plan* and Executive Order 12866 which require assessing the costs and benefits of alternative strategies for environmental protection. As a result, the program will improve the scientific basis for performing more comprehensive valuations of ecosystem services than is currently possible by clarifying the economic, social and ecological ramifications of various management options.

Exploratory Grants and Nanotechnology Research

EPA's Nanomaterials research program generates decision-support information to promote the safe development, use, and disposal/recycling of products that contain engineered nanoscale materials ("nanomaterials"). Based on analyses by EPA's Office of Research and Development and the Organization for Economic Cooperation and Development (OECD) as to which nanomaterials are most likely to present near- to medium-term human and ecological exposure, the EPA research program focuses on five types of nanomaterials: carbon tubes and fullerenes, cerium oxide, iron, silver, and titanium dioxide. The FY 2011 nanotechnology budget request is $20 million, including $3.7 million in the Land research program, $13.9 million in the Human Health and Ecosystem research program, $2 million in the Fellowships program, and $0.23 million in both the Clean Air and Sustainability research programs.

Guided by EPA's Nanomaterial Research Strategy, the program utilizes in-house research and the STAR grants program[67] to examine nanomaterials from two interrelated perspectives: (1) whether these materials present the potential for hazard or exposure over their life cycles, and (2) how these materials, as used in products, may be modified or managed to avoid or mitigate potential human health or ecological impacts. The program also is coordinated nationally as part of the National Nanotechnology Initiative,[68] and internationally through the OECD's Working Party on Manufactured Nanomaterials.[69] EPA's Nanotechnology Research Program supports the regulatory activities of the Prevention, Pesticides, and Toxic Substances program, as well as remediation strategies developed by the Solid Waste and Emergency Response program and implemented through EPA's Regional Offices.

In FY 2011, EPA's Nanomaterial research program will continue source-to-dose research (releases/emissions; fate, transport, and transformation; and exposure) to identify which of the five material types, in what forms, may become present in biological systems at concentrations of potential concern. The program will investigate and evaluate approaches to detect, measure and characterize nanomaterials in environmental media. Results expected from this research in FY 2011 include reports on laser detection of nanomaterials, electrochemical detection methods, and screening methods for metal-containing nanoparticles in water. The program also will evaluate existing applications and new methods to understand behavior of nanomaterials in the environment, with published reports including nanomaterial deposition on mineral and organic surfaces. In FY 2011, EPA expects to release a report on observed toxicities and the possibility of using existing test methods to predict toxicities in freshwater, marine and terrestrial systems. The program will publish state-of-the-science reports for nanoscale silver and titanium dioxide. Source-to-dose research will enable risk assessments that better reflect actual nanomaterial forms and their concentrations in air, water, and soil; and how people or wildlife may be exposed to them.

FY 2011 funding will continue support for green nanotechnology research to link exposure and effects research with green chemistry and life-cycle assessment research. Research will identify how nanomaterial properties may be modified or exposure controls implemented to minimize

[67] For more information, see: http://www.epa.gov/ncer/nano/
[68] For more information, see http://www.nano.gov/
[69] For more information, see http://www.oecd.org/site/0,3407,en_21571361_41212117_1_1_1_1_1,00.html

and manage the potential of risk from products containing nanomaterials and minimize inputs, including energy usage, during the production of nanomaterials.

In 2011 EPA will develop a screening-level life cycle assessment for nanoscale silver and strategies for eco-friendly synthesis of nanomaterials. The advancement of safer nanomaterial production with a smaller environmental footprint, through green nanotechnology research, will benefit both producers and consumers.

EPA also will continue to develop comprehensive environmental assessment and decision analytic approaches to support long term as well as near to medium term needs for evaluating potential impacts of nanomaterials, particularly in the absence of adequate information for conventional risk assessment methodologies. A case study prioritizing research needed to support a comprehensive environmental assessment of selected applications of nanoscale silver will be released in FY 2011. Developing these new analytical approaches will enable decision makers to make better decisions, sooner, with a broader appreciation for where in a nanomaterial's life cycle there exists the greatest potential to avoid or manage risks.

Report on the Environment

In FY 2011, EPA will improve the utility of the Report on the Environment (ROE) by fine-tuning indicators (revising, adding, deleting), integrating conceptual diagrams, and including supplemental information to fill identified data gaps. EPA will also explore the feasibility of adding energy and climate chapters. The ROE will continue to play a critical role in the Agency's strategic planning activities as the Agency develops and implements more transparent and outcome-oriented measures and indicators. This program is based on strong intra-agency and interagency partnerships with active participation from EPA Headquarters and Regional Offices to ensure that the ROE provides credible and defensible indicators that can best inform planning and decision making at the Agency. The ROE has a steering committee of Agency senior managers who provide guidance and feedback to the ROE.

EPA's 2008 Report on the Environment was released in May 2008 as a scientific document that presents the condition of and trends in the nation's environment and human health. The ROE uses data from state and federal agencies for over half of the indicators (e.g. USDA, CDC, DOI). EPA released an interactive public website (the "eROE") to provide greater transparency on how EPA can improve its ability to assess the nation's environmental quality and human health, and how EPA uses that knowledge to better manage measureable environmental results. The eROE is updated quarterly with the most recent environmental indicator data and enhancements at www.epa.gov/roe. The next complete revision and hard copy release of the ROE is planned for FY 2012.

Advanced Monitoring Initiative

In FY 2011, the Advanced Monitoring Initiative (AMI) will work with EPA programs, offices, and Regional Offices to bring the best monitoring data and modeling results to improve decisions made by EPA and its partners. It will benefit fully from the interagency U.S. Group on Earth Observations (USGEO) Initiative and support the international community through the "Global Earth Observing System of Systems (GEOSS)," primarily as a user of data and information,

through partnerships with Federal agencies. The GEOSS architecture integrates environmental observation, monitoring, and measurements with modeling that directly support health, climate change, air quality, and other social benefit areas. AMI will augment ongoing efforts on data collection and management with an Agencywide effort to provide a "knowledge base," and the tools to access and utilize it effectively.

In FY 2011, AMI will support EPA's three-to-five year cross-agency science priorities, particularly in the areas of climate and energy, environmental contaminants, and modernization of infrastructure. For each priority, the AMI initiative will focus primarily on the development of decision support tools needed for implementation. EPA also will focus on environmental technology project performance, which will be further strengthened through a rigorous quality assurance and performance based management process.

In addition, to respond to U.S. environmental technology needs, EPA USGEO's approach is to integrate environmental observation, monitoring, measurements, modeling, green technology development, commercialization and verification of development, technology transfer and applications of data, and information collected for decision making and tools. The GEOSS AMI will support environmental technology activities and integrated multi-disciplinary research that aligns with the Agency's science priorities.

Mercury Research

EPA has developed a multi-year plan for studying mercury, including its sources, control and treatment, environmental fate and behavior, impacts on ecological resources, and potential effects on human health. In FY 2011, the mercury program will discontinue research to evaluate the transport of mercury from power plant stacks, including plume transport and ultimate deposition (e.g. mercury "hot spots") analyses. This discontinuation will minimize the impact to the highest priority work in the human health and ecosystems research program, such as ecosystem services and children's health research. The program will release a report of mercury "hot spots" research completed in previous fiscal years. In FY 2011, research to support implementation of revised regulations to control mercury and co-pollutants from coal-fired utility boilers and other combustion sources will be discontinued. Studies to develop or evaluate the cost and performance of emissions control technologies capable of reducing mercury and co-pollutants will be curtailed, resulting in more limited data for inclusion in planned products and reports.

Performance Targets:

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of Ecological Research publications rated as highly-cited publications.	21.4	Data Avail 2010	No Target Established	22.4	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of Ecological research	21.3	Data Avail	No Target Established	22.3	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
	publications in "high-impact" journals.		2010			

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of public health outcomes long-term goal.	100	100	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of mechanistic data long-term goal.	100	100	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of aggregate and cumulative risk long-term goal.	100	100	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of the susceptible subpopulations long-term goal.	100	100	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of human health program publications rated as highly cited papers.	No Target Established	Biennial	26.5	No Target Established	Percent

The research conducted under these programs supports EPA Strategic Objective 4.4. Specifically, these programs identify and synthesize the best available scientific information, models, methods, and analyses to support Agency guidance and policy decisions with a focus on human, community, and ecosystem health.

The programs gauge their annual and long term success by assessing progress on several key measures. In FY 2011, the Human Health Research program plans to accomplish its goals of completing and delivering 100 percent of its planned outputs. The program also is targeting increases in the percentage of its peer reviewed risk assessments which are cited as supporting a decision to either move away from or to apply default risk assessment assumptions, as was encouraged in the 2005 BOSC review, and in determining the extent to which key research products are cited in EPA decision documents. The program will conduct a retrospective analysis over the last ten years, because it can take many years for the development of regulatory documents. This can result in a long lag time between publication of research results and their being cited by EPA.

In preparation for the FY 2007 mid-cycle and FY 2009 full BOSC reviews of the Human Health program, advanced computer programs were used to search EPA dockets and determine the extent to which scientific publications from this program were used in risk assessments, decision and policy documents, and guidance reports by EPA and other government regulators. Bibliometric analyses also were applied to measure the quality and stature of the journals in which Human Health papers were published and the extent to which these papers were cited in other scientific journals. Thus quantitative measures of both scientific quality and program relevance were incorporated into the BOSC review process.

In FY 2011, the ESRP intends to meet 100 percent of its planned outputs in support of each long term goal while increasing program efficiency. In addition, based on research previously completed under this program, EPA plans to have forty-five states use a common monitoring design and appropriate indicators to determine the status and trends of ecological resources and the effectiveness of programs and policies. In its ongoing efforts to improve the ecosystem research program, EPA is engaging its BOSC to evaluate whether the Agency's research and development programs are "doing the right research and doing it well."

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$1,254.0) This represents a restoration of resources transferred in FY 2010 to the Research: Sustainability program to support Small Business Innovation Research (SBIR). For SBIR, EPA is required to set aside 2.5 percent of funding for contracts to small businesses to develop and commercialize new environmental technologies. After the FY 2011 budget is enacted, and the exact amount of the mandated requirement is known, FY 2011 funds will be transferred to the SBIR program.

- (+$800.0) This increase reflects a redirection of resources to the Human Health and Ecosystems program to fund ECOTOX, which is a database for locating single chemical toxicity data for aquatic life, terrestrial plants and wildlife. Various programs have contributed to needed access and updates, and maintaining them.

- (+$500.0) The Agency is working to reduce its carbon footprint by promoting green travel practices and moving routine meetings to a web or video conference format. In order to be successful, strategic investments in video/web conferencing capabilities are

necessary. Funds will support the creation of multi-use conference rooms in selected locations, as well as the needed internet capacity.

- (-$326.0) This decrease in travel costs reflects an effort to reduce the Agency's travel footprint by promoting green travel and video conferencing.

- (+$576.0) This reflects an increase for payroll and cost of living for existing FTE.

- (-$1,787.0 \ -6.5 FTE) This decrease reflects the net result of realignments of FTE and resources such as equipment purchases and repairs, travel, contracts, and general expenses to better align with programmatic priorities and includes a reduction of 6.5 FTE and decreased associated payroll of -$877.0. The FTE reduction includes 5.0 FTE for the Ecosystem Services STAR grants program. Realignments are based on FTE allocations as well as scientific equipment needs.

- (-$1,000.0) This decrease reflects administrative savings in the Human Health and Ecosystems program that are being reinvested in STAR fellowships.

- (-$2,435.0 \ -3.1 FTE) This reflects a reduction to the mercury research program and includes a reduction of 3.1 FTE and decreased associated payroll of $418.0. The program will discontinue research examining mercury "hot spots'" evaluating mercury emission measurement/control technologies, and assessing the impact of different coals and technology configurations on coal combustion residues. The program will use data already generated to produce final products and reports.

- (-$3,000.0) This reduction is the result of an increase included in the FY 2010 Appropriation providing an additional $3 million for children's environmental health research in FY 2010, of which $2 million was directed to the new centers of excellence on children's environmental health, with at least one of these centers to focus on child care settings, and $1 million to accelerate research on the effects of environmental chemicals and toxins on children. This increase is not included in the FY 2011 budget request.

Statutory Authority:

CAA; SDWA; ERDDA; CWA; FIFRA; FFDCA; RCRA; FQPA; TSCA; USGCRA.

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	*$28,200.0*	*$27,347.0*	*$27,645.0*	*$298.0*
Total Budget Authority / Obligations	$28,200.0	$27,347.0	$27,645.0	$298.0
Total Workyears	135.2	137.4	136.3	-1.1

Program Project Description:

The Pesticides and Toxics Research program conducts integrated multidisciplinary research to provide the scientific foundation for the Agency's actions to protect human health and the environment against unreasonable risks from exposure to pesticides and toxic chemicals. The program identifies and synthesizes the best available scientific information, models, methods, and analyses to support Agency guidance and policy decisions related to the health of people, communities, and ecosystems, with a focus on pesticides and toxic chemicals. This research complements work conducted under the Human Health and Ecosystem Research, the Human Health Risk Assessment, and the Endocrine Disruptors Research programs and supports the Administrator's priorities for assuring the safety of chemicals. The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering.

Research to develop and validate methods and models and assessments for predicting risks from pesticides and toxic substances is conducted under the Pesticides and Toxics research program. EPA's Pesticides and Toxics Research program provides the scientific foundation for the Agency's actions to protect against unreasonable risk from exposure to toxics and pesticides.

Research is guided by the Biotechnology Research Strategy[77] and the Wildlife Research Strategy,[78] which were developed with broad participation from major clients and stakeholders (e.g. EPA's Prevention, Pesticides and Toxic Substances program and Regional Offices). The strategies outline the Agency's research needs and priorities. The Safe Pesticides/Safe Products (SP2) multi-year plan (MYP)[79] outlines specific steps for meeting these needs, as well as annual performance goals and measures for evaluating progress.

77 U.S. EPA, Office of Research and Development. *Biotechnology Research Strategy*. Washington, DC: EPA. Available at: http://www.epa.gov/nheerl/publications/files/biotechnology_research_program_4_8_05.pdf.

78 U.S. EPA, Office of Research and Development, *Wildlife Research Strategy*. Washington, D.C.: EPA. Available at: http://www.epa.gov/nheerl/publications/files/wildlife_research_strategy_2_2_05.pdf.

79 U.S. EPA, Office of Research and Development, Safe Pesticides/Safe Products Multi-Year Plan. Washington, D.C.: EPA (2006). Available at: http://epa.gov/ord/npd/pdfs/SP2+MYP+120106final.pdf.

The program primarily focuses on developing methods, models, and data for use in decisions by EPA's Prevention, Pesticides and Toxic Substances program and other organizations. The research program has three major goals:

- Provide predictive tools to prioritize testing requirements; enhance interpretation of data to improve human health and ecological risk assessments; and inform risk management decision-making regarding high priority pesticides and toxic substances;
- Develop probabilistic risk assessment methods and models to better protect natural populations of birds, fish, other wildlife, and non-target plants; and
- Provide the tools necessary to make risk management decisions related to products of biotechnology. However, in FY 2010 and FY 2011, the program will phase out biotechnology work.

In February 2007, the Pesticides and Toxics research program underwent an external peer review by EPA's research advisory committee, the Board of Scientific Counselors (BOSC), which commended the progress and direction of the research and provided recommendations for improvement.[80] The BOSC stated that "SP2 [Safe Pesticides and Safe Products] is a very successful program. The research is of high quality and is focused on well-articulated goals. Its relevance to the Agency's mission is clear and apparent, and the SP2 program fills a unique niche within the Agency, and serves the needs of OPPTS, its major client, very well." The BOSC also noted that, "the scientists involved in these projects are internationally recognized and their findings and organized panels serve to establish regulatory guidance around the world."

EPA and its external reviewers, including the EPA Science Advisory Board and National Science Foundation, have recognized that a statute-specific research approach is limited in its potential for solving modern environmental problems. While the Pesticides and Toxics research program and Human Health research program have both made many important contributions to EPA decision-making and have worked to integrate various disciplines throughout the programs, these external reviews have noted that EPA could benefit by building upon important synergies and emerging tools to address evolving environmental problems. Therefore, moving in that direction, portions of the Pesticides and Toxics research program are being integrated with related aspects of the Human Health research program. The result is a more holistic research program that maximizes responsiveness to the rapidly changing needs of EPA's program and Regional Offices and other critical partners. In mid-2010, the BOSC will review the progress of the SP2 research program in implementing the BOSC's previous recommendations.

FY 2011 Activities and Performance Plan:

In FY 2011, the resources for Pesticides and Toxics research will continue to support the scientific foundation for addressing risks from human and wildlife exposure to pesticides and toxic chemicals. EPA will provide research on methods, models, and data to support prioritization of testing requirements, enhanced interpretation of data to improve human health

80 U.S. EPA, Office of Research and Development, SP2 Research Program Review. Washington, D.C. (2007). Available at: http://www.epa.gov/osp/bosc/pdf/sp2070723rpt.pdf.

and ecological risk assessments, and decision-making regarding specific individual or classes of pesticides and toxic substances that are of high priority.
This research will continue to focus on:

- Developing proteomic, metabolomic, and transcriptomic biomarkers and other approaches for assessing toxicity in fish;
- Developing alternative test methods for the hazard identification of potential human developmental neurotoxicants;
- Developing a database of metabolic maps for use in prioritization and chemical risk assessment;
- Characterizing the toxicity and pharmacokinetics of certain perfluorinated chemicals (PFCs); and
- Developing sampling and analytical methods and evaluating the fate and transport of certain PFCs in soil and wastewater.

Research conducted in FY 2011 also will support the development of probabilistic risk assessments to protect natural populations of birds, fish, other wildlife, and non-target plants. This research directly supports Agency efforts to assure that endangered species are protected from pesticides while making sure farmers and communities have the pest control tools they need. Four key components of this research are:

- Extrapolation among wildlife species and exposure scenarios of concern;
- Population biology to improve population dynamics in spatially-explicit habitats; for example, developing tools to characterize fate and transport through wastewater treatment plants of certain pharmaceuticals and their impact on aquatic organisms;
- Models for assessing the relative risk of chemical and non-chemical stressors; and
- Models to define geographical regional/spatial scales for risk assessment.

The program will develop methods for characterizing population-level risks of toxic substances to aquatic life and wildlife. Results of this research will help the Agency meet the long term goal of developing scientifically valid approaches for assessing spatially-explicit, population-level risks to wildlife populations and non-target plants and plant communities from pesticides, toxic chemicals and multiple stressors while advancing the development of probabilistic risk assessment. This supports the Agency's obligations under the Endangered Species Act to ensure that regulated use of pesticides will not harm listed species or their critical habitat.

Researchers in the Pesticides and Toxics and Human Health research programs will work together on integrated, goal-oriented issues, and will plan and execute work to develop high capacity decision support tools for managing contaminants across their life-cycles. The program will provide partners with a more efficient means of assessing exposure and hazards of chemicals. Partners will be able to efficiently evaluate the impact of large numbers of chemicals in everyday commerce on human health (individual and susceptible populations) facilitating prioritization for further chemical research, management, and product design decisions.

In coordination with the Endocrine Disruptors research program, portions of the Pesticides and Toxics research program will be aligned with portions of the Human Health research program to

focus on high-priority problems affecting management of contaminants. This base shift will improve our ability to develop tools that improve chemical management, one of EPA's top priorities.

The Pesticides and Toxics Research program continues to implement key improvement steps. The program developed a formal response to the BOSC report and is addressing action items and making progress toward long-term and annual targets.

Performance Targets:

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of the SP2 program's long-term goal two.	100	100	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percent of SP2 publications in "high impact" journals.	No Target Established	Biennial	37.2	No Target Established	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of SP2 publications rated as highly cited publications.	No Target Established	Biennial	24.2	No Target Established	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of the SP2 program's long-term goal three.	100	100	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of the SP2 program's long-term goal one.	100	100	100	100	Percent

The research conducted under this program supports EPA Strategic Objective 4.4. Specifically, the program identifies and synthesizes the best available scientific information, models, methods,

and analyses to support Agency guidance and policy decisions related to the health of people, community, and ecosystems, with a focus on pesticides and toxic chemicals. A key focus for FY 2011 will be to develop the scientific underpinning related to the effects, exposures, and risk management of specific individual or classes of pesticides and toxic substances that are of high priority to the Agency in order to inform risk assessment/management decisions.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$1,251.0) This reflects an increase for payroll and cost of living for existing FTE.

- (+$510.0 \ +2.0 FTE) This reflects an increase for research to address exposure issues related to potential chemical and/or pesticide stressors and realignment of FTE to better reflect the programs they support and includes 2.0 FTE with associated payroll of $258.1. This change reflects EPA's workforce management strategy that will help the agency better align resources, skills and Agency priorities.

- (-$287.0 \ -2.2 FTE) This reflects the net result of realignments of FTE and resources such as critical equipment purchases and repairs, travel, contracts, and general expenses to better align with programmatic priorities, and includes a reduction of 2.2 FTE with decreased associated payroll of $283.9. Realignments of these resources are based on FTE allocations as well as scientific equipment needs. This change reflects EPA's workforce management strategy that will help the agency better align resources, skills and Agency priorities.

- (+$16.0) This represents a restoration of resources transferred in FY 2010 to the Research: Sustainability program to support Small Business Innovation Research (SBIR). For SBIR, EPA is required to set aside 2.5 percent of funding for contracts to small businesses to develop and commercialize new environmental technologies. After the FY 2011 budget is enacted, and the exact amount of the mandated requirement is known, FY 2011 funds will be transferred to the SBIR program.

- (-$50.0) This decrease in travel costs reflects an effort to reduce the Agency's travel footprint by promoting green travel and conferencing.

- (-$1,142.0 \ -0.9 FTE) This reflects a reduction to research supporting the development of scientific tools for biotechnology and includes a reduction of .9 FTE with decreased associated payroll of $116.2. The program will reduce research into refining the use of remote sensing as a tool for the management of insect resistance in genetically modified crops, also known as Plant Incorporated Pesticides (PIP) crops. The program has completed research on decision support systems to identify insect infestations that would indicate the development of insect resistance.

Statutory Authority:

FQPA; FIFRA; TSCA; CWA; CAA; ERDDA.

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	*$5,760.7*	*$11,083.0*	*$17,286.0*	*$6,203.0*
Total Budget Authority / Obligations	$5,760.7	$11,083.0	$17,286.0	$6,203.0
Total Workyears	6.2	2.6	5.0	2.4

Program Project Description:

EPA places a high priority on ensuring that our nation has a large and well-trained scientific and engineering workforce that can address complex environmental issues. The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering. To help achieve excellence in science and technology education in these and other areas, EPA offers five programs that encourage promising students to obtain advanced degrees and pursue careers in environmentally-related fields.

According to a July 2004 publication by the National Science and Technology Council entitled *Science for the 21st Century*, beginning in 1998, the U.S. experienced a significant decline in science and engineering doctorates. EPA's fellowships programs help address this decline by educating new academic researchers, government scientists, science teachers, and environmental engineers. They also play a key role in developing a talent pool from which EPA can recruit and hire scientists. The following are EPA's current fellowships programs:

Science to Achieve Results (STAR Fellowship Program)[47] EPA's STAR Fellowship program supports master's and doctoral candidates in environmental studies. Students in the U.S. compete for STAR fellowships through a rigorous review process. The review process is merit-based and takes into consideration whether the proposed area of the applicant's research and study will:

- Strengthen the scientific basis for environmental management decisions and practices;
- Produce data, methods, or practices to help the scientific or regulated community to better understand and/or manage complex environmental problems;
- Provide a focus for future research and technology development in science, engineering, or modeling approaches for assessing and managing environmental risks; or
- Focus on the potential of the research outputs to have broader societal impacts.

[47] For more information, see http://epa.gov/ncer/fellow.

On average, approximately ten percent of STAR program applicants receive a fellowship. Students can pursue degrees in traditionally recognized environmental disciplines, as well as other fields such as social anthropology, urban and regional planning, and decision sciences. To support these advanced degree-seeking students, EPA provides assistance for up to three years in the form of a stipend ($20,000/year), a research budget ($5,000/year) and tuition assistance (up to $12,000/year). The program has provided new environmental research in physical, biological, health and social sciences, and engineering. At least one student from each of the 50 states, the District of Columbia, and Puerto Rico has received an EPA STAR Fellowship.

Greater Research Opportunities (GRO) Undergraduate Fellowship Program:1 EPA's GRO Undergraduate Fellowship program helps build capacity in universities that receive limited funding for research and development by awarding fellowships to undergraduate students in environmental fields. These institutions receive less than $35 million annually in Federal science and technology funds. Eligible students receive support for their junior and senior years of undergraduate study and complete an internship at an EPA facility during the summer between their junior and senior years. EPA provides up to $19,250 a year for academic support and $8,000 of support for the three-month summer internship with EPA. In addition to conducting quality environmental research, fellows agree to maintain contact with EPA for at least five years after graduation. EPA uses the information gathered from its fellows to track their success in pursuing advanced degrees in environmental studies and finding a career in science and engineering. Of the fellows who received fellowships between FY 2003 and FY 2006 and reported information to EPA, 78 percent reported that they were working or studying in an environmentally-related field.

Environmental Science and Technology Policy Fellowship Program:[48] In conjunction with the American Association for the Advancement of Science (AAAS), EPA places qualified technical professionals with a Ph.D. degree or equivalent in EPA headquarters for up to two years to design and work on projects at the interface of science and policy. In this way, fellows develop a better understanding of the needs of policymakers and how to make their research more meaningful to those who depend on it. EPA's interests are wide ranging, and fellows can work on any environmentally relevant issue within EPA's jurisdiction. Fellows are awarded annual stipends ranging between $70,000 and $95,000. Since the program began in 2005, EPA has hosted 263 fellows, and these fellows have been placed in every program office within EPA. Currently, EPA hosts roughly a dozen fellows each year.

Environmental Public Health Fellowship Program:[49] To enhance the training of highly qualified and motivated public health professionals, EPA, in conjunction with the Association of Schools of Public Health (ASPH), offers professional development opportunities to graduates of accredited U.S. schools of public health who have received at least a Master of Public Health or equivalent degree within the last five years. The goal of the program is to provide real-world experience in environmental public health issues to complement participants' academic training. These fellows are placed in EPA laboratory, regional, program or research management offices across the country. Fellows are awarded annual stipends of up to $50,000 and funding to defray health insurance costs and a travel and professional development budget. EPA's goal is to place 32 fellows in EPA Headquarters, Regional Offices, and laboratories each year.

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[48] For more information, see http://fellowships.aaas.org/01_About/01_Partners.shtml#EPA.
[49] For more information, see http://www.asph.org/document.cfm?page=751&JobProg_ID=1.

EPA Marshall Scholarship Program:[50] In FY 2005, EPA began a partnership with the government of the United Kingdom under the auspices of the highly regarded Marshall Scholarship program. Since 1953, the Marshall Scholarship program has provided opportunities for highly motivated students to receive support for two years of graduate study in Great Britain, culminating in a Master's Degree. The EPA Marshall Scholarship program extends that opportunity for students who are interested in environmental careers, particularly those fields that address environmental problems of a global nature or benefit multilateral efforts. Under this program, eligible students who successfully complete the first two years as a Marshall Scholar may receive up to three more years of support towards the award of a doctoral degree in an environmentally-related technical discipline. Marshall Scholars receive approximately $40,000 a year to cover university tuition and fees, a stipend, program-related expenses, and travel to and from the United States.

These five fellowship programs represent a long term investment aimed at:

- Enhancing environmental research and development,
- Improving the nation's promotion of green principles, and
- Increasing the nation's environmental workforce, post secondary environmentally-related educational opportunities, and environmental literacy.

A subcommittee of EPA's Board of Scientific Counselors (BOSC)—a Federal advisory committee composed of qualified, independent scientists and engineers—conducted a review of the STAR and GRO fellowship programs in March 2006. The subcommittee reported that "the fellows funded by the STAR and GRO programs have made excellent contributions in environmental science and engineering, and a number of them continue to be employed in the environmental field...the EPA programs clearly are of value to the Agency and the nation in helping to educate the next generation of environmental scientists and engineers."[51]

FY 2011 Activities and Performance Plan:

One of the Administration's top priorities in 2011 is strengthening science, technology, engineering, and mathematics education at every level (from pre-college to post-graduate to lifelong learning). This program supports that priority by helping to ensure the Nation has a diverse workforce to meet the scientific, technological, and engineering challenges of tomorrow. It is an investment in EPA's future and our ability to ensure that science remains the backbone of EPA for years to come. The FY 2011 budget request would provide more than a 75 percent increase for fellowships. New fellowships will be awarded through nationwide competition in academic areas that are top priorities for EPA including nanotechnology, climate and clean air issues, and green infrastructure. EPA will award approximately 240 new STAR fellowships in addition to providing support for an estimated 120 continuing STAR fellows. Fellowship recipients will complete progress and exit reports, and the Agency will maintain contact

[50] For more information, see http://www.marshallscholarship.org/applications/epa.
[51] EPA, Board of Scientific Counselors, *Review of the Office of Research and Development's Science To Achieve Results (STAR) and Greater Research Opportunities (GRO) Fellowship Programs at the U.S. Environmental Protection Agency.* Washington, D.C.: EPA (2006), 1–2. See http://epa.gov/osp/bosc/pdf/star0609rpt.pdf.

information and follow up data on former fellows. The program also will select and arrange hosting for AAAS and ASPH recipients and support a portion of eligible Marshall Scholarship recipients.

EPA has incorporated "Broader Impacts Criteria" into its STAR and GRO Undergraduate Fellowship programs. Broader Impacts Criteria require the applicant to address issues other than the intellectual merit of their research proposal. These criteria require an applicant to address, among other things, what broader impacts the applicant may have as a fellow, such as furthering environmental awareness, stewardship, equity, and broadening participation of underrepresented groups in science, technology, engineering, and mathematics (STEM). Incorporating Broader Impact Criteria into EPA's fellowship programs not only strives to enhance the diversity found in the country's scientific community, but also supports EPA's immediate human capital goal to attract and retain a diverse and talented workforce by nurturing the supply of diverse persons going into environmentally-related fields.

Performance Targets:

Work under this program supports EPA's Objective 4.4: Enhance Science and Research. Currently, there are no external performance measures for this specific program. However, EPA's Research and Development program will likely begin an external evaluation of the Fellowships program in FY 2011.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$6,000.0) This request reflects a more than 75 percent increase for science and engineering fellowships under the Science to Achieve Results (STAR) Graduate Fellowship program, including $2 million for nanotechnology fellowships. The increase also supports the Administration's priorities for investing in a diverse science, technology, engineering, and mathematics workforce.

- (-$314.0) This decrease is the net effect of increases for payroll and cost of living for existing FTE, combined with a reduction based on the recalculation of base workforce costs.

- (+$353.0 / +2.4 FTE) This increase reflects the net result of realignments of resources such as critical equipment purchases and repairs, travel, contracts, and general expenses to better align with programmatic priorities, including 2.4 FTE with associated payroll of $343.0. Realignments of these resources are based on FTE allocations as well as scientific equipment needs. This change reflects EPA's workforce management strategy that will help the Agency better align resources, skills and Agency priorities.

- (+$164.0) This represents a restoration of resources transferred in FY 2010 to the Research: Sustainability program to support Small Business Innovation Research (SBIR). For SBIR, EPA is required to set aside 2.5 percent of funding for contracts to small businesses to develop and commercialize new environmental technologies. After the FY 2011 budget is enacted, and the exact amount of the mandated requirement is known, FY 2011 funds will be transferred to the SBIR program.

Statutory Authority: CAA; CWA; FIFRA; NCA; RCRA; SDWA; TSCA; ERDDA.

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	*$19,445.7*	*$27,287.0*	*$25,292.0*	*($1,995.0)*
Hazardous Substance Superfund	$96.0	$73.0	$0.0	($73.0)
Total Budget Authority / Obligations	$19,541.7	$27,360.0	$25,292.0	($2,068.0)
Total Workyears	64.7	70.8	70.7	-0.1

Program Project Description:

EPA's Science and Technology for Sustainability (STS) Research program provides information and tools for Agency program and Regional Offices as well as external stakeholders to promote sustainable approaches to address environmental problems affecting health and the environment. EPA's focus on and commitment to promoting sustainability–achieving economic prosperity while protecting natural systems and quality of life for the long term–is rooted in the Pollution Prevention Act of 1990. The STS Research program provides the scientific foundation for the Agency's advancement of sustainability through systems research and integrated analysis of air, water, and land resources, and of changes in traditional methods of producing and distributing goods and services. Adoption of sustainability concepts in environmental management will rely heavily on scientific advances that provide technologies and decision tools to inform future risk management decisions. As decision makers adopt these new sustainable approaches, they will need appropriate metrics to measure the impacts of public and private actions in the context of sustainability. The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering.

In a 2007 review of the STS Research program, the EPA's Board of Scientific Counselors (BOSC) concluded that the STS program had significantly responded to its recommendations and that it "exceeds expectations" in achieving long term goals for the adoption of technology and tools[74]. The BOSC suggested the STS program apply its tools and approaches to key national issues. Subsequently, the STS program has focused a significant part of its efforts on research aimed at sustainable biofuel production. In July 2009, the BOSC conducted an evaluation and determined that the STS program "exceeds expectations with respect to progress and responsiveness to the 2007 review." STS will continue implementing BOSC recommendations.

[74] For more information, see http://www.epa.gov/osp/bosc/pdf/sust0803rpt.pdf.

The STS Research program provides scientific and technical support to regional and national sustainability policies and initiatives. To this end, the STS program has established three areas of emphasis:

- *Sustainability Metrics:* As sustainable solutions to environmental problems are developed and implemented, the progress and impact of these efforts needs to be measured. STS research in this area provides the underlying science needed to develop, apply, and implement these metrics. The STS Research program focuses its efforts on developing scientifically-based sustainability metrics and indices that will support understanding of the implications of different technology and risk management pathways, evaluation of regional ecosystem sustainability over time, and assessment of how various management strategies can move a region towards sustainability.

- *Decision Support Tools*:[75] This research creates tools, models, and methods that provide information to decision makers on ways to evaluate, from a systems perspective, environmental management issues in order to achieve sustainable outcomes. This research is built on the foundation of life cycle and supply chain analysis techniques. These techniques address the sustainability of alternative policy options, production pathways, and product usage by describing the full environmental impact and sustainability implications of each alternative. Such methods and techniques are applied to consumer products, municipal solid waste management, biofuel production, chemical production, and energy generation.

- *Technologies:* This research emphasizes the development and testing of technologies that facilitate sustainable outcomes. An example of ongoing technical work is the development and evaluation of a new membrane technology that can recover biofuel from biomass streams at higher purity levels using 50 percent less energy and at lower cost than current technology. An external collaborator, Membrane Technology & Research, has further developed this technology and applied for two patents listing EPA as co-inventor.[76] Programs such as the Small Business Innovation Research (SBIR) program and the People, Prosperity, and Planet (P3) student design competition emphasize finding solutions to client-driven problems while promoting sustainable design and implementation practices that generate research ***outputs*** in the form of innovative, inherently benign, integrated, and interdisciplinary designs that will advance the scientific, technical, and policy knowledge necessary to further the goals of sustainability.

The STS program promotes and supports national and regional sustainability policies and initiatives. The program ensures that decision makers within EPA and at the local, regional, and national levels have a sound set of scientific principles and management tools that promote stewardship and sustainability outcomes.

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[75] For more information, see http://www.epa.gov/ord/NRMRL/std/sab .

[76] For more information, see Section II – Page 184 of EPA's FY 2009 Performance and Accountability Report at http://www.epa.gov/cfo/par/2009par/par09_goal5.pdf .

FY 2011 Activities and Performance Plan:

The STS program will continue development and implementation of systems metrics, which represent the measurement of overall system function and health on a broad regional scale. In partnership with the Forest Service and many state and local stakeholders in the San Luis Valley of Colorado, the STS program worked in FY 2010 to develop four system-based sustainability metrics (ecological and economic) to be used by environmental managers in supporting sustainable outcomes. In FY 2011, the program will validate and apply these metrics. The program also will begin research to apply sustainability metrics to management of regional ecosystems in Puerto Rico. This study will enhance the robustness of the metrics effort by applying the metrics to different types of regional ecosystems (e.g. more urban development and industrial activity). Additionally, research will continue to develop tools and data that will be used to evaluate the sustainability of different pathways to produce, distribute, and use biofuels.

In support of one of the Administrator's top priorities, assuring the safety of chemicals, the STS program will initiate a new research effort in FY 2011 to mitigate human exposure and environmental releases from the recycling and disposal of electronic waste. Through new design methods, EPA will work with industry to promote changes to manufacturing and other processes, such as refurbishing and recycling aiming to reduce adverse human health and environmental impacts and decrease the volume of unwanted electronic devices. Lifecycle analyses of electronic devices will develop tools and methods to assess the environmental impacts of the production, use, and end-of-life management of electronic devices and electronic device components.

As part of the Agency's Clean Energy and Climate Change initiative, the STS program will continue to support the biofuels research initiative started in FY 2010 to help decision makers better understand the risk tradeoffs associated with biofuels use and production. The STS program is coordinating the preparation of EPA's Report to Congress, mandated under the Energy Independence and Security Act 2007 (EISA) Section 204, on the current and anticipated future environmental impacts due to expanded biofuel production in the U.S. Such assessments are due every three years. The first report to Congress is due December 2010 and will be followed by a research workshop in 2011. Research in support of EISA will examine proposed feedstocks and assess their potential impacts on the environment, aiding the development of approaches that provide for sustainable production of biofuels.

Research also will continue for other decision support tools, including efforts to further develop a streamlined in-house life cycle assessment methodology and to incorporate material flow concepts into existing tools. The STS program will continue work on a water use model and will complete a model for assessing environment impact for land use. STS research will also continue to evaluate an auction-based management approach to wet weather flow management in urban watersheds using the Cincinnati and Cleveland metropolitan areas as case studies.

Finally, the STS program will maintain funding for the development of new innovative technologies through the People, Prosperity and Planet (P3) program. This program advances the development of environmental technology testing protocols and a global environmental technology network, encourages innovation in environmental stewardship, and provides educational opportunities in the fields of science, technology, engineering, and mathematics.

In FY 2011, the STS Program will deliver several tools, models, guidance, and reports to inform state and Federal regulatory decision makers. In order to evaluate the sustainability of biofuel production, the STS program will expand the suite of environmental impact assessment models to include sustainable land use. The program also will provide decision makers at the local level with recommendations on the effectiveness of a small-parcel approach incorporating best management practices for managing urban watersheds.

The STS program is taking steps to improve performance through the development of a revised Science and Technology for Sustainability Multi-Year Plan (MYP) by 2010, a key recommendation from the BOSC. The STS program also continues to measure performance through several annual output and long term outcome measures. The next BOSC review is expected to occur in 2013.

Performance Targets:

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of STS's goal that decision makers adopt ORD-developed decision support tools and methodologies.	100	100	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of STS's goal that decision makers adopt innovative technologies developed or verified by ORD.	100	100	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of Science and Technology for Sustainability (STS) publications in "high impact" journals.	35.3	35.4	No Target Established	36	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
Output	Percentage of planned outputs delivered in support of STS's goal that decision makers	100	100	100	100	Percent

Measure Type	Measure	FY 2009 Target	FY 2009 Actual	FY 2010 Target	FY 2011 Target	Units
	adopt ORD-identified and developed metrics to quantitatively assess environmental systems for sustainability.					

Work under the STS Research program supports EPA's Strategic Plan Objective 5.4: Enhance Science and Research. The STS program measures and manages performance through the timely completion of research milestones and the citation rates of research publications. In FY 2011, the program plans to continue making progress toward its long term objective of providing information and tools for Agency program and Regional Offices as well as external stakeholders to promote sustainable approaches to address environmental problems affecting health and the environment.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (+$1,000.0) This reflects a new research focus on design methods and management strategies for electronic devices to mitigate human exposure and environmental releases from the recycling and disposal of electronic waste. This research supports the Agency's priority for assuring the safety of chemicals.
- (+$295.0) This reflects an increase for payroll and cost of living for existing FTE.
- (-$60.0 \ -0.1 FTE) This decrease reflects the net result of realignments of resources such as equipment purchases and repairs, travel, contracts, and general expenses to better align with programmatic priorities and includes a reduction of .1 FTE with decreased associated payroll of $13.0. Realignments of these resources are based on FTE allocations as well as scientific equipment needs. This change reflects EPA's workforce management strategy that will help the Agency better align resources, skills and Agency priorities.
- (-$47.0) This decrease in travel costs reflects an effort to reduce the Agency's travel footprint by promoting green travel and conferencing.
- (-$3,183.0) This reflects an adjustment for Small Business Innovation Research (SBIR). Enacted funding levels for SBIR include the amount EPA is required to set aside for contracts to small businesses to develop and commercialize new environmental technologies. This adjustment is necessary because the SBIR set aside, at this point in the budget cycle, is redistributed to other research programs in the President's Budget request. After the budget is enacted, and the exact amount of the mandated requirement is known, the funds will be transferred to the SBIR program.

Statutory Authority:

CAA; CWA; FIFRA; PPA; RCRA; SDWA; SBA; SARA; TSCA; ERDDA; EISA.

(Dollars in Thousands)

	FY 2009 Actuals	FY 2010 Enacted	FY 2011 Pres Bud	FY 2011 Pres Bud v. FY 2010 Enacted
Science & Technology	$19,445.7	$27,287.0	$25,292.0	($1,995.0)
Hazardous Substance Superfund	*$96.0*	*$73.0*	*$0.0*	*($73.0)*
Total Budget Authority / Obligations	$19,541.7	$27,360.0	$25,292.0	($2,068.0)
Total Workyears	64.7	70.8	70.7	-0.1

Program Project Description:

Under the Small Business Research (SBIR) program[24], as required by the Small Business Act as amended[25], EPA sets aside 2.5 percent of its extramural research budget for contracts to small businesses to develop and commercialize new environmental technologies. Since its inception, EPA's SBIR program has provided incentive funding to small businesses to translate their innovative ideas into commercial products that address environmental problems. These innovations are the primary source of new technologies that can provide improved environmental protection at lower cost with better performance and effectiveness.

SBIR has helped spawn successful commercial ventures that not only improve our environment, but also create jobs, increase productivity and economic growth, and enhance the international competitiveness of the U.S. technology industry. The range of research programs and initiatives will both continue the work of better understanding the scientific basis of our environmental and human health problems as well as advance the design of sustainable solutions through approaches such as green chemistry and green engineering. SBIR, the only activity contained in this program, is currently not funded under the Superfund account.

Performance Targets:

Work under this program supports EPA's Enhance Science and Research objective. The performance measures that support this Program Project can be found in the Science and Technology appropriation Program Project.

FY 2011 Change from FY 2010 Enacted Budget (Dollars in Thousands):

- (-$73.0) This reflects an adjustment for Small Business Innovation Research (SBIR). Enacted funding levels for this program include the amount EPA is required to set aside for contracts to small businesses to develop and commercialize new environmental

[24] For more information, see http://epa.gov/ncer/sbir.
[25] U.S. Public Law 219. 79th Congress, 2nd session, 22 July 1982. *Small Business Innovation Development Act of 1982.* For more information, see http://thomas.loc.gov

technologies. This adjustment is necessary because the SBIR set aside, at this point in the budget cycle, is redistributed to other research programs in the President's Budget request. After the budget is enacted and the exact amount of the mandated requirement is known, the funds will be transferred to the SBIR program.

Statutory Authority:

CAA; CWA; FIFRA; PPA; RCRA; SDWA; SBA; SARA; TSCA.